INTEGRATED AQUATIC VEGETATION MANAGEMENT PLAN
FOR
ROSES LAKE

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PROJECT OVERVIEW

Roses Lake (previously known as Alkali Lake) is located in Chelan County in Eastern Washington. It is a small lake, which is connected via a small channel/wetland system to Dry Lake, which in turn is connected to Lake Chelan via Stink Creek. Roses Lake has recently been infested with Eurasian watermilfoil and the primary purpose of this project was to develop a strategy to control the impacts from this plant.

Eurasian watermilfoil (EWM) was first noted in the lake in 2001 and inhabited less than 4 acres. By 2005, over 12 acres of the lake were infested with this invasive plant. A small patch of fragrant waterlily another potentially invasive non-native plant also exists in the lake. Due to concerns about the negative impacts of these plants, the residents of Roses Lake banded together to apply for a planning grant from the State Department of Ecology (Ecology) to develop an Integrated Aquatic Vegetation Management Plan (IAVMP) to address aquatic plant problems. This effort began with collecting the funds needed to meet the in-kind match requirements associated with the grant. This money was primarily collected through voluntary contributions from lake residents, with some support from Chelan County. After being awarded a grant, the community advertised for and selected EnviroVision to develop the plan. The planning process included a series of public and steering committee meetings ending with final agreement on the recommended plan.

This report provides a description of the aquatic plant control plan developed for Roses Lake. The basic recommendations selected for aquatic plant control in this lake are:

- An initial treatment of all identified Eurasian watermilfoil (EWM) with the herbicide 2,4-D. Possible follow-up treatments with either 2,4-D or Triclopyr depending upon distribution of EWM.
- Long-term follow-up with annual diver surveys and handpulling of remaining plants or use of bottom barrier or Triclopyr depending upon plant distribution characteristics. The goal is eradication of EWM.
- Use of glyphosate (Rodeo) to eradicate fragrant waterlily and any other invasive shoreline plants identified (e.g. tamarisk, yellow flag iris, reed canarygrass, or purple loosestrife)
- Use of glyphosate to reduce the bulrush community near residences and control the long-term spread of this plant.
- Establishment of an Aquatic Plant Advisory Committee for the lake whose function is to make decisions annually about controls needed and review aquatic plant management goals.

PUBLIC INVOLVEMENT

Public Involvement has included steering committee meetings and public meetings. Each element is described below. All meeting planning, organization and documentation (Appendix A) was provided by the Roses Lake Association.

The first public meeting for Roses Lake was held on May 29, 2005. At that meeting an overview of aquatic plant management issues was presented and the planning process for development of this IAVMP was described. The group completed the problem statement, identified and developed management goals and mapped beneficial uses. The meeting ended with a Questions and Answers session on general lake problems and control techniques.

A steering committee meeting was then held on August 5, 2005. This meeting began with a summary of the results from an aquatic plant survey performed in July, then an overview of available aquatic plant control strategies was provided. However, the meetings primary focus was discussing the options most applicable to Roses Lake. These included whole-lake fluridone (Sonar) applications, partial lake fluridone (Sonar) applications (with the use of barriers) and areal treatments with liquid 2,4-D (DMA*41VM). After some discussion it was agreed that only the less expensive liquid 2,4-D options should be further considered and that an option that included only treatment around the developed shoreline should be added. (In the following document, references to 2,4-D refer to the liquid formulation.)

The second public meeting was held on September 25, 2005. At that meeting the overview of available aquatic plant control strategies was provided again to insure people understood how the final control scenarios were initially selected. However, the majority of the meeting was spent discussing two recommended control scenarios and funding considerations. The group unanimously agreed that eradication of milfoil as described in this plan was their preferred strategy.

LAKE AND WATERSHED CHARACTERISTICS

PHYSICAL CHARACTERISTICS

Roses Lake (previously known as Alkali Lake) is located in Chelan County in Eastern Washington. It is a small lake, which is connected via a small channel/wetland system to Dry Lake, which in turn is connected to Lake Chelan via Stink Creek. The entire system (Roses Lake, Dry Lake, Stink Creek and the connecting channel between the lakes) was artificially "enhanced" through dam building and irrigation canal construction work that occurred in the early 1900's (LCRD 2004). During that time, a dam was built that blocked the outlet of nearby Wapato Lake and further raised the elevation of Wapato Lake so that it is now approximately 60 feet higher than Roses and Dry Lakes. Due to the subsurface hydraulic connection between the lakes, this elevation change resulted in changing Roses Lake from an intermittent water body or wetland of approximately 60 acres (referred to as an alkali bed in maps from 1908) to its current 130 acres of year-round open water (Figure 1). In addition to subsurface flow from Wapato Lake, there is a subsurface agricultural drain that flows into the lake. There are no surface streams to the lake. The lake drains a watershed of approximate 524 acres and has a surface area of 130 acres. The lake has a mean and maximum depth of 23 feet and 31 feet, respectively. No information on flow characteristics or water residence time is available for the lake. However, the lack of surface inflow and the fact that no distinct stream channel forms the outflow indicates that water residence time is likely very high especially during the summer. Physical characteristics of the lake are summarized in Table 1.

Table 1. Physical characteristics of Roses Lake.

Characteristic	English Units	Metric Units
Watershed area	524 acres	212 hectares
Surface area	130 acres	53 hectares
Lake volume	2,990 ac-ft	
Littoral Area	30.4 acres	12.3 hectares
Maximum depth	31 feet	9.5 meters
Mean depth	23 feet	7.0 meters
Shoreline length	2.2 miles	3.54 Kilometers

The land surrounding the lake is largely comprised of orchards. There are only a few lakeside residences, most of which are used as recreational homes. These are almost all located at the southeast end of the lake. Currently there are about 18 residential lots identified along this shore with 10 more slated for development. Another 4 lots are planned for development on the northwest end of the lake.

Public access is provided via a public boat launch along the southwest shoreline and at least four private boat launches on the lake (Figure 2).

WATER QUALITY

The most common way lakes are classified is by their trophic state, which defines a lake in relation to the degree of biological productivity and is an indirect indicator of water quality. Lakes with low nutrients, low algae levels, and clear water are classified as nutrient poor or "oligotrophic". Lakes with high nutrients, high algae levels, and low water clarity are classified as nutrient rich or "eutrophic". "Mesotrophic" lakes have water quality characteristics between these two classifications.

Classifying a lake based on its trophic state is a useful way to describe changes in a lakes' water quality over time and assess the potential sensitivity of a specific lake to additional nutrient loading. Total phosphorus, chlorophyll *a*, and transparency are the three water quality parameters most often used to rate the overall trophic condition of a lake. Phosphorus is one of the essential nutrients for plant growth; including the microscopic plants known as algae. Total phosphorus includes all soluble, organic, and particulate forms of phosphorus. Chlorophyll *a* is one of a family of green pigments that allows green plants to perform photosynthesis. Chlorophyll *a* concentration correlates with the abundance of algae in a lake. Water transparency is commonly measured as the depth at which a black-and-white disk (i.e., Secchi disk), when lowered into the water, ceases to be visible. Algal growth, organic acids, and suspended materials all influence Secchi depth transparency. Threshold values for determining trophic state are presented in Table 2, along with values for Roses Lake. Nutrient concentrations are high in the lake. The average annual concentration of total phosphorus (TP) was 30 ug/L, about 10% of which was in the soluble reactive form (SRP) and therefore available to promote algae growth. Average annual chlorophyll concentrations were 10.5 ug/L. These nutrient and chlorophyll concentrations reflect a eutrophic condition.

Table 2. Trophic State Classification [(1)]

Trophic State	Total Phosphorus (µg/L)	Chlorophyll *a* (µg/L)	Transparency (meters)
Oligotrophic	< 10	< 4	> 4
Mesotrophic	10 - 20	4 - 10	2 - 4
Eutrophic	>20	>10	< 2
Roses Lake [(2)]	30	10.5	1.85

[(1)] As modified from Gilliam, R.J. and G.C. Bortleson. 1983.
[(2)] These are average annual values from monitoring in 2002 at station R1 (Source: LCRD 2004)

Water quality data was collected in Roses Lake during a 2002 and 2003 study of the "Mason Lakes" (Roses, Dry and Wapato) done by the Lake Chelan Reclamation District. The purpose of the study was to assess the extent to which DDT or its derivatives were still a problem and the transport mechanisms for this pollutant and also to assess phosphorus loading and other conventional water quality parameters. Two stations were monitored on the lake (R1 and R2); however, the results from the two were essentially the same. Table 3 contains a summary of the data from station R1 from this study. According to the study results (LCRD 2004), the irrigation drain water that enters Roses Lake is a significant contributor of nutrients and DDT. Soluble phosphorus concentrations as high as 160 ug/L and nitrate nitrogen concentrations of 10,000 ug/L were measured in this system (LCRD 1998). These concentrations are likely 50 to 100 times higher than the highest concentrations measured in the lake. The very high nutrient concentrations in the irrigation drains were attributed to failing septic systems in the drainage area. Although the lake had lower nutrient concentrations than the irrigation ditches, lake concentrations were still quite high (Table 3) and well above the threshold for eutrophic conditions. These high nutrient concentrations corresponded to high chlorophyll concentrations. Chlorophyll is an indirect measure of algae concentrations and algae problems do occur in this lake.

Table 3. Summary of Roses Lake Water Quality Data from 2002 and 2003 (Source: LCRD 2004).

Parameter	Range	Average
Total Phosphorus (ug/L)	14 - 45	30
Soluble Reactive Phosphorus (ug/L)	2 - 5	3
Chlorophyll a (ug/L)	1.6 - 22	10
Dissolved Oxygen (mg/L)	8 – 12.2	9.42
pH (pH units)	8.7 – 9.1	Not Applicable
Alkalinity (as mg/L CaCO3) (2)	267 - 270	268.5
Total DDT(3) (ppb or ug/L)	0.0015 – 0.0102	0.0031
Sediment DDT (ug/Kg TOC) (4)	188 - 840	522

(1) Based on results at Station R1and 10 measurements between March and December 2002.
(2) Based on two measurements.
(3) Based on 16 measurements in lake discharge water.
(4) Based on four sediment samples from different parts of the lake collected on one day.

The most critical water quality concern associated with Roses Lake is the existence of pesticides and pesticide derivatives in sediment and fish tissue samples. DDT was introduced in 1948 and used in orchard lands in the area surrounding Roses Lake until 1972, when it was banned. During a 1994 study (Ecology 1997), elevated levels of 4',4'-DDE (a DDT derivative) were measured in sediment and fish tissue samples in the three lakes (Wapato, Roses, and Dry) area. The fish tissue samples of DDE from Roses Lake exceeded human health criteria set by EPA and lake sediment concentrations of DDT were significantly greater than the severe effects level of 12,000 ug/Kg TOC. As a consequence, Roses Lake was included in the list of "impaired waterbodies" referred to as the 303(d) list in 1996. Once a waterbody is included in this list, a plan for clean up or recovery of the waterbody must be developed.

In 2002 and 2003, additional monitoring was performed in the area to further identify the extent of the problem and sources of the toxin and movement through the environment (LCRD 2004). The following is a summary of some of the results from that study. DDT was consistently detected in Roses Lake water at concentrations that exceeded the chronic toxicity concentration of 0.001 ug/L. The average concentration measured was 0.0031 ug/L. Soil testing results indicated that DDT still exists throughout the soil profile at concentrations similar to what was measured in orchard soils 20 years ago. It is moving into the lakes through two mechanisms; erosion of soils and movement through the soil profile to the irrigation drains. Lake sediment testing indicated that although DDT levels are still high in the sediments, they are now well below the severe affects level. It was assumed that the decrease in the sediments was a function of the contaminated sediments being buried or diluted by the accumulation of new sediment. As a result of this study, Roses Lake was removed from the list.

FISH AND WILDLIFE AND RARE PLANT COMMUNITY

Roses Lake is considered by WDFW to be a very important resource for both fish and wildlife. It, and the associated wetland, provides breeding and nesting habitat for waterfowl and other wildlife; and supports mule deer and western gray squirrel populations that are locally significant (Steele, R. Pers. Comm.) Roses Lake is also a popular fishing destination. It provides a year-round fishery for largemouth bass, perch, black crappie, bluegills, trout, and channel catfish (Viola, A. Pers. Comm.). It is an especially popular ice-fishing lake. The lake shore is also home to many birds, turtles, snakes and other wildlife that are valued by the lake residents and other users.

WDFW typically stocks the lake twice annually (March and November) with rainbow trout. According to WDFW's 2005 stocking plan, a total of 15,350 rainbow trout were to be stocked in the lake, some in March and some in November. In 2003 and 2004, 17,250 brown trout were also stocked in addition to the rainbow (WDFW 2005a). Trout are generally stocked at a catchable size (i.e., 8-12 inches in length for brown trout (Viola, A. Pers. Comm.). Bass, crappie and catfish have also been previously planted at the lake (WDFW 2005b).

A search and query of State and federal databases for threatened, endangered or sensitive species was made during development of this project. The Western Gray Squirrel, a state threatened species and a federal species of concern, has been observed at several locations in the general vicinity of Roses Lake. This species also nests in the area, though no nests are located at the lake (WDFW 2005c). None of the activities planned for the lake would be expected to impact nesting, feeding, or foraging habitat for this species.

A search of the Natural Heritage Information System on significant natural features within a 2-mile radius of Roses Lake resulted in no records. It is important to note, that the database searches only existing information. There may be rare plant species or high quality ecosystems in the area of which WDNR is not aware (WDNR 2005).

WATER USE INFORMATION

Washington State Department of Ecology was contacted to provide information regarding the water rights for diversions out of Roses Lake. Results from a query of the Water Rights Tracking System (WRATS) for T28N, R21E, S23, 25 and 26, indicated that the three certificates and three permits for diversion from the lake were classified as inactive. A few groundwater claims existed, but there are no active water rights for diversions out of the lake (Turner, S. Pers. Comm. August 2005). Even though there are no active water rights for lake water, water still could be drawn from the lake and not adequately reported. This is why notification and posting are important requirements for all herbicide applications.

WETLANDS

A map of area wetlands has been included in Appendix D. The riparian area associated with the outlet stream (Dry Creek) is a wetland, and there is also a small (less than 1 acre) wetland mapped on the northern shoreline. Both wetland areas are classified as freshwater emergent wetlands. (USFWS August 2005).

AQUATIC PLANT COMMUNITY

Previous to this study, the lake aquatic plant community was surveyed by Ecology in 1994, 1997, and 2001. The primary submerged aquatic plant found in the lake before the 2001 study year was native milfoil. In terms of floating leaved plants, a small patch of fragrant waterlily, a non-native noxious aquatic plant was first noted in 1997, sago pondweed was also abundant. The emergent plants included the cattails and bulrush that have recently been identified as a problem; these were already well established along the shore. In 2001 Eurasian watermilfoil was first noted in the survey; the plants were noted as being dense in the east end of the lake but otherwise having a wide and patchy distribution. Reed canarygrass, a noxious emergent plant was also first noted in the 2001 survey.

2005 Plant Survey

The aquatic plant community was surveyed on July 20, 2005 to document plant coverage. The survey was done via boat using an underwater viewing scope and rake sampler to identify plant communities. Differential global positioning equipment (gps) was used to mark the plant community edges. This information was downloaded and used to create a map of the plant community (Figure 1) and to provide estimates of plant acreage. Table 4 lists the plants observed in Roses Lake during recent surveys.

Plant Characterization

The plant growth distribution in Roses Lake is depicted in Figure 1. The growth zone for the submerged plants can largely be defined by the 15-foot depth contour. Less than 25 percent of the total surface area (30.4 acres out of 130) of Roses Lake is covered with submerged aquatic vegetation (SAV). Approximately 40% of the SAV area (i.e., 12.5 acres) contains the invasive species Eurasian watermilfoil (*Myriophyllum spicatum*). The other dominant submerged plant is a native milfoil (*Myriophyllum sibericum*). The emergent plant zone, which is primarily comprised of bulrush (*Schoenoplectus tabernaemontani*), surrounds the entire lake perimeter to a distance of about 10 feet from shore. The very small patch (< 50 sq. ft.) of fragrant waterlily identified in earlier surveys still exists and surprisingly does not appear to have exhibited the rapid growth and colonization that is typical for this plant.

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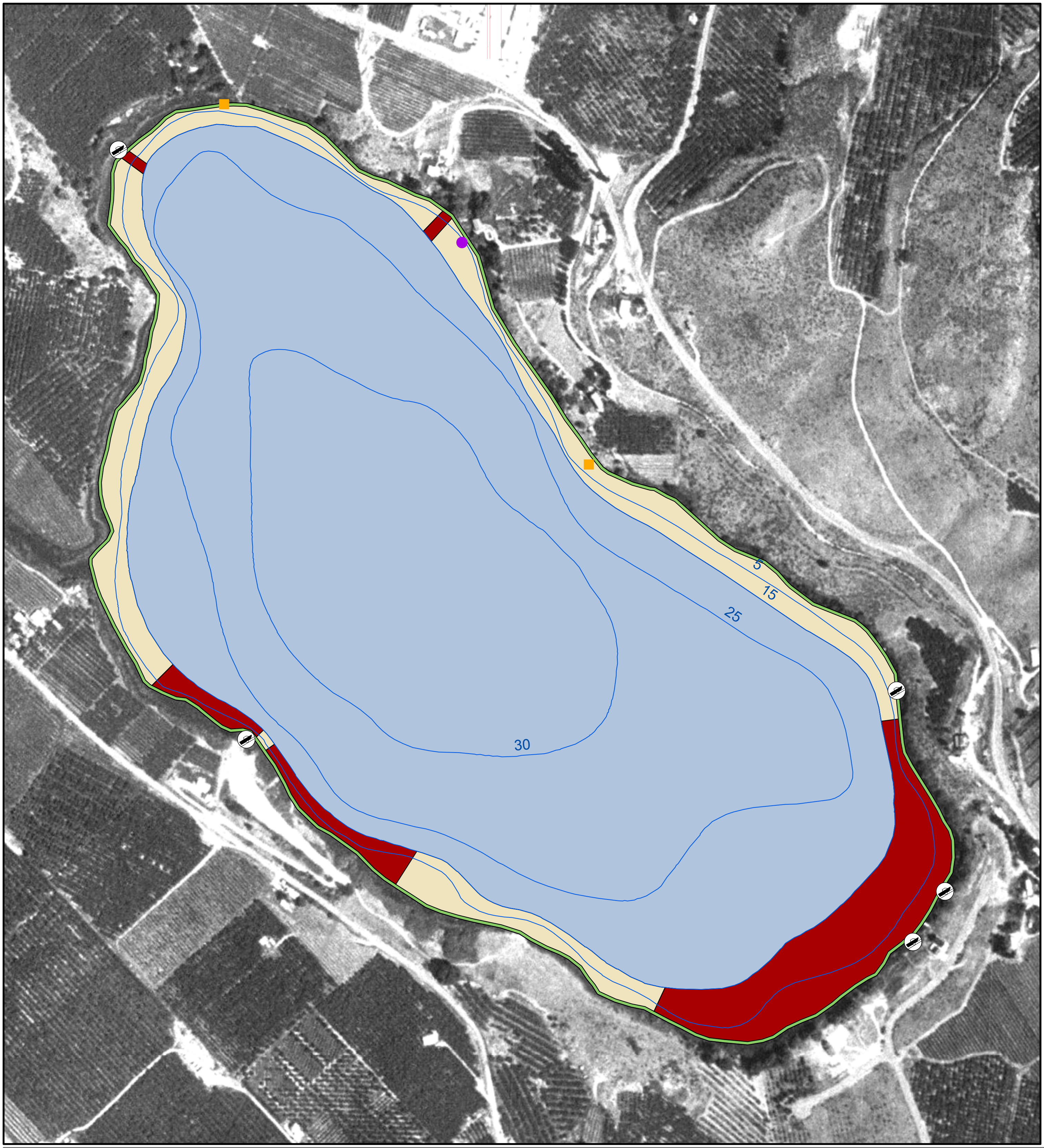

Eurasian milfoil (Mixed)

Submerged Aquatic Plants (no Eurasian milfoil)

Bulrush

Fragrant waterlily

Reed canarygrass

Boat Launch

Depth Contour (ft)

Figure 1. Roses Lake, Chelan County, Aquatic Plant Survey July 20, 2005

0 250 500 1,000 1,500 Feet

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Table 4. List of aquatic plant species at Roses Lake.

Species	EnviroVision 2005 Distribution Value[1]	Previous Ecology Distribution Value[2]	Comments
EMERGENT PLANTS			
Western water hemlock *Cicuta douglasii*	1		One plant observed on SE shore
Spikerush *Eleocharis* sp.	2		
Reed canarygrass *Phalaris arundinacea*	2	3	Present only in two locations in 2005 survey.
Softstem bulrush *Schoenoplectus tabernaemontani* [(3)]	4	4	Visible all along lake shore.
Bulrush *Scirpus sp.*		4	Ecology's surveys of 1997, 2001
Nightshade *Solanum* sp.		1	Ecology's 2001 survey.
Common Cat-tail *Typha latifolia*	3	3	Present along the North & East shore in 2005 survey.
Cat-tail *Typha* sp.		2	Ecology's 1997 survey.
FLOATING-LEAVED PLANTS			
Fragrant waterlily *Nymphaea odorata*	1	1	By dock on eastern shore.
SUBMERSED PLANTS			
Coontail *Ceratophyllum demersum*	3	1	
Duckweed *Lemna minor*		2	Observed only in Ecology's 1997 survey.
Northern milfoil *Myriophyllum sibericum*	3-4	3	Present in surveys of 1994, 1997 and 2001.
Eurasian milfoil *Myriophyllum spicatum*	3-4	2	First observed in Ecology's 2001 survey.
Common smartweed *Polygonum hydropiperoides*		1	Present in Ecology's 2001 survey.
Sago pondweed *Potamogeton pectinatus*	3	3	Ecology referred to this as: *Stuckenia pectinata*
Thin leaved pondweed *Potamogeton sp*		1	Present in Ecology's 1997 survey
Ditch-grass *Ruppia cirrhosa*	3-4	3	Present in Ecology's surveys of 1994, 1997 and 2001
ALGAE			
Algae *Chara* sp.	2		
Filamentous green algae	3		Throughout lake.

(1) Distribution value is an estimate of density: 1 – few plants in only 1 or a few locations; 2 – few plants, but with a wide patchy distribution; 3 – plants growing in large patches, co-dominant with other plants; 4 – plants in nearly monospecific patches, dominant; 5 – thick growth covering the substrate at the exclusion of other species.
(2) Ecology's distribution values were obtained from surveys on August 31, 1994, June 17, 1997 and September 11, 2001. For species that were observed in multiple years, the most recent distribution value was used.
(3) The taxonomic name for this plant was recently changed from *Scirpus tabernaemontani.*

The following information on these problem aquatic plants was summarized from Ecology's website (http://www.ecy.wa.gov/programs/wq/links/plants.html).

> Eurasian watermilfoil (*Myriophyllum spicatum*) was once commonly sold as an aquarium plant. It originated in Europe and Asia, but was introduced to North America many years ago and is now found over much of the United States. It has been known to exist in Washington State since at least 1965 and is now found throughout the State. The introduction of milfoil can drastically alter a waterbody's ecology. Milfoil forms very dense mats of vegetation on the surface of the water. These mats interfere with recreational activities such as swimming, fishing, water skiing, and boating and can also interfere with things like power generation and irrigation by clogging water intakes.
>
> The sheer mass of plants can cause flooding and the stagnant mats can create good habitat for mosquitoes. Milfoil mats can rob oxygen from the water by preventing the wind from mixing the oxygenated surface waters to deeper water. The dense mats of vegetation can also increase the sedimentation rate by trapping sediments. Milfoil also starts spring growth sooner than native aquatic plants and can shade out these beneficial plants. When milfoil invades new territory, the diversity of aquatic plants species within the system typically declines. While some species of waterfowl will eat milfoil, it is not considered to be a good food source.
>
> Milfoil reproduces extremely rapidly and can infest an entire lake within a few years of introduction. Milfoil is able to reproduce very successfully and rapidly through the formation of plant fragments. In the late summer and fall the plants become brittle and naturally break apart. These fragments will float to other areas, sink, and start new plants. Milfoil will also grow from fragments created by boaters or other disturbances during any time of year. A new plant can start from a tiny piece of a milfoil plant. This is why milfoil can so easily be transported from lake to lake on boat trailers or fishing gear. Once established in its new home, water currents may carry milfoil fragments and start new colonies within the same waterbody.
>
> Fragrant water lilies (*Nymphaea odorata*) are exceptionally beautiful water plants with floating leaves and large many-petaled fragrant blossoms. They are wonderful additions to backyard ponds and even "tub gardens" but unfortunately have also been intentionally planted in many Washington lakes. The nursery industry has hybridized them and produced many color variations. They sell tropical water lilies and hardy water lilies. It is the hardy white and (sometimes) pink lilies that have become problems in Washington lakes and rivers.
>
> Water lilies grow in dense patches, excluding native species and even creating stagnant areas with low oxygen levels underneath the floating mats. These mats make it difficult to fish, water ski, swim, or even paddle a canoe through. Although relatively slow-spreading, water lilies will eventually colonize shallow water to a depth of six feet deep and can dominate the shorelines of shallow lakes. For this reason, planting water lilies in lakes is not recommended.
>
> Water lilies reproduce by seed and also by new plants sprouting from the large spreading roots (underground stems called rhizomes). A planted rhizome can cover about a 15-foot

diameter area in about five years. If pieces of the rhizome are broken off during control efforts, they will drift to other locations and establish a new patch of lilies. Also because the plants produce flowers and seeds continually through the summer, the seed supply created is large. These two mechanisms for reproduction are the key to this plants ability to quickly invade shallow areas of lakes.

<u>Softstem bulrushes</u> are tall, stout, perennial plants with round, olive green stems, drooping brown flower clusters near the stem tips, and a few inconspicuous leaves at the stem bases. This plant is commonly found in marshes and along shorelines in water up to 1.5 m deep. They are found nearly worldwide and are native to Washington. Propagation is through seeds and underground horizontal rhizomes from which roots and multiple stems arise.

Softstem bulrush provides habitat for invertebrates and shelter for young fish. The nutlets (seeds) are consumed by a wide variety of waterfowl, marsh birds and upland birds. Stems and rhizomes are eaten by geese and muskrats. The plants also provide nesting material and cover for wildlife. The plant has also been used as a food and material supply source by native cultures.

Although this is a beneficial plant, its ability to quickly colonize shallow waters in the nearshore margin of lakes can greatly impede human access and accelerate lake filling.

BENEFICIAL USE

During the first public meeting held for development of this plan, people were asked to develop a list of beneficial uses the lake provides and identify where those uses occur. Figure 2 depicts the key results from this discussion. Beneficial uses identified included swimming, boating, fishing, waterskiing, wildlife viewing, and fish and wildlife habitat. There is no public swimming beach; as a consequence swimming is concentrated near the residential area making it coincident with the greatest EWM population. There is a water ski course set near the northwest section of the lake that attracts many non-lake residents, due to the often flat-water conditions. The lake is also a popular fishing destination. Fishing includes wintertime ice fishing. WDFW stocks the lake with rainbow trout twice each year (spring and winter) to enhance the ice fishing opportunities. Some of the wildlife that utilize the lake include; frogs, bald eagles, muskrat, osprey and many turtles. According to lake residents, although there was a previous water withdrawal for irrigation, it is no longer used.

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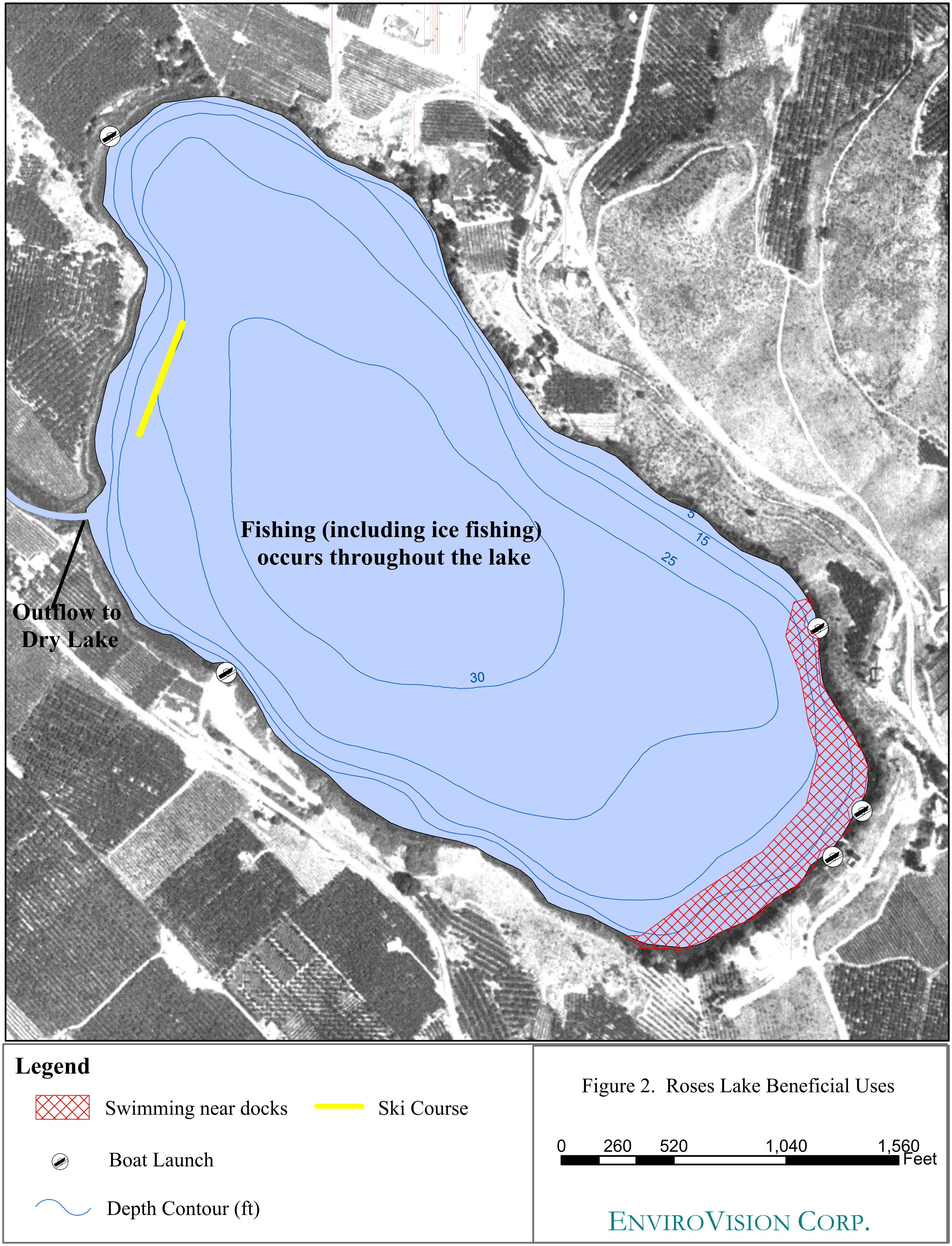

Figure 2. Roses Lake Beneficial Uses

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PROBLEM STATEMENT FOR ROSES LAKE

The following list of problems was developed at a May 2005 meeting of the Roses Lake Association and through site investigations.

- ◊ Over a period of about four years, Eurasian watermilfoil has taken over more than 12 acres of the lake.
- ◊ Bulrush is expanding and extending the shoreline from 10 to 30 feet, making it difficult to use the nearshore area. This plant was not here 20 years ago.
- ◊ Milfoil may have been a contributing factor to two recent drowning deaths; plants were found around the legs of the victims.
- ◊ A small patch of fragrant waterlily exists near the northeast section of the lake and represents a potential problem if not eliminated or controlled.
- ◊ Native plants may also be a problem in some parts of the lake due to excessive growth.

Other problems identified that are not necessarily related to aquatic plants but may need to be considered when identifying control strategies were also listed.

- ◊ Gnats and/or "no-see-ums" and deerfly are more of an issue on this lake than other nearby lakes. This may be due to the emergent plant (bulrush) beds providing habitat.
- ◊ Geese are an increasing problem.
- ◊ DDT is at high levels in area soils.

The list of problems was used to create a problem statement for Roses Lake. The purpose of the problem statement is to describe as clearly as possible how the lake and its inhabitants are being negatively impacted by aquatic plants.

> *Over the past 4 years Eurasian watermilfoil has invaded Roses Lake. This plant has expanded from occupying about 4 acres a few years ago to over 12 acres by 2005. If left unchecked, over 30 acres of the lake surface area is expected to be affected by this dense, noxious plant. This plant is limiting recreational use; especially boating, fishing, and swimming, and may have contributed to drowning incidents. The presence and expansion of bulrush beds are also limiting access to the nearshore area and are creating another safety hazard due to the difficulty in seeing children at the waters edge. The large nearshore emergent plant zone is also a likely factor for attracting nuisance levels of insects. Last, a small patch of fragrant waterlily exists in the lake that needs to be eliminated before it reaches nuisance levels and further impedes use of the lake.*

AQUATIC PLANT MANAGEMENT GOALS

The final step before beginning development of a plant control plan was to define project goals. This is a critical step because the goals are used to determine what control strategies will work and will ultimately be used to evaluate whether the program has been a success. The following list of goals was developed during the May 2005 meeting of the Roses Lake Association.

- Eradicate Eurasian watermilfoil. Eradication was selected instead of a control-based strategy because the milfoil has not yet spread throughout the lake and represents less than 10% of the submerged aquatic plant beds.
- Allow control of bulrush in area around homes. Currently, homeowners are limited to controlling a 10-foot wide strip for their dock. This does not allow room for other nearshore uses such as swimming and docking boats. Since the developed area represents only a small fraction of the shoreline perimeter, the vast majority of the habitat provided by the bulrush would remain.
- Provide a long-term plan for control of native, nuisance plants. There are already some parts of the lake where native plants are at problem levels. It is possible that these will become a greater problem in the future.
- Maintain diverse fish and wildlife habitat. The lake currently has a wide diversity of fish, songbirds, waterfowl, turtles and other wildlife and these are highly valued by lake residents.

AQUATIC PLANT MANAGEMENT OPTIONS

There are two primary needs associated with the aquatic plant community in Roses Lake, Eurasian watermilfoil eradication and control/suppression of the bulrush in the area near residences. Over the long-term it is possible that native plants will reach nuisance levels, thus a long-term plan that allows some control near residences and possibly near the water ski course needs to be considered. All control alternatives described and approved by Ecology (1994) were considered for use in Roses Lake. These included the use of various herbicides, mechanical removal or harvesting, sediment dredging, stocking Grass Carp, and other techniques. Appendix B provides summary information on these control methods, a summary of their advantages and disadvantages as well as appropriateness for use in Roses Lake. The process of selection began with presenting the entire range of control alternatives typically available to Washington State residents and describing the advantages and disadvantages of each and how each might best be utilized on the lake. This information was presented at a steering committee meeting on August 5, 2005. At that meeting three different options for eradication of the milfoil were also discussed. The options included a whole-lake liquid Sonar treatments, partial lake liquid Sonar using water impermeable curtains to create barriers around the two treatment zones, and use of 2,4-D in the two treatment zones with extensive diver survey follow-up.

Through discussions with the steering committee these options were narrowed and refined to eliminate the more expensive Sonar options and to also consider an option that involved only treating the southeast section of the lake. The options that were brought to the final meeting included:

- Whole lake eradication of EWM using 2,4-D and follow-up with handpulling and/or bottom barrier and/or the herbicide Triclopyr
- Treatment of the south end only with a contact herbicide such as diquat or endothall to achieve seasonal control of the EWM.
- Using 2,4 D one time to decrease the milfoil volume and then stocking with grass carp to provide long-term suppression of all plants.

After thoughtful discussion of the differences in cost and weighing the reliability of the different strategies as well as potential for long-term satisfaction, eradication of EWM using 2,4-D was selected as the preferred strategy.

RECOMMENDED AQUATIC PLANT CONTROL PLAN

IMMEDIATE CONTROL STRATEGY (WATERMILFOIL & WATERLILY ERADICATION)

The most critical aspect of the Aquatic Plant Control Plan for Roses Lake is eradication of the EWM. The first step in the process is to perform a thorough diver survey of the plant community. This survey should be performed in June or July 2006 to allow time for the milfoil to grow. The divers should mark the outside boundaries of the 4 identified EWM patches as well as thoroughly survey the remaining shoreline, covering the area from 0 to 20 feet deep. All EWM locations should be located by gps and marked as points or polygons. A map and summary report should be provided within two weeks of the survey. This survey information should be provided to the herbicide applicator. The applicator should treat all identified EWM with the herbicide 2,4-D (liquid formulation) within two-weeks to one month of receiving the survey report. Since there is no salmon use in this lake, timing restrictions on use of 2,4-D related to salmon are not relevant.

This summer treatment should by followed by another diver survey about one month after the treatment and possible re-treatment with 2,4-D if large patches remain, or if more milfoil is discovered in untreated areas of the lake. During this dive survey, divers should again identify and locate all EWM plants via a gps unit with sub-meter accuracy, but also be prepared to handpull plants where they are sparsely distributed in small areas. (This becomes a subjective call by the divers. A few patches of sparsely distributed plants can be handpulled but many areas of even sparsely distributed plants become inefficient to handpull.) The dive team should prepare a map and summary report identifying where plants were found, where they were handpulled, where bottom barrier is recommended, and whether another 2,4-D treatment should be planned or whether spot treatment with Triclopyr might be recommended. (Triclopyr may be more effective for killing these plants but is also more expensive.) If follow-up treatment with

2,4-D is recommended, it should be done within two weeks of the survey up until mid September. (Note: If the survey is done too late in the summer to allow time to schedule an herbicide application, it is preferable to wait until the following spring to both survey and treat.) Collection of lake water samples after the treatment is likely to be required if this work is done through a grant from Ecology. These requirements will be defined in the grant agreement.

Each year a summary report should be prepared to track treatment and effectiveness. At a minimum, the report should detail the cost for each treatment, the cost for the herbicide, the amount of herbicide used, acreage treated and the application method followed.

This routine of surveys and treatment (either by handpulling, placing bottom barrier or applying herbicide) should continue at least once a year for five years. Use of 2,4-D should not be considered as an effective eradication strategy without intensive follow-up survey work. (The diver surveys can be supplemented by boat surveys by local residents and eventually replaced by these boat surveys once the milfoil is eradicated. However, since this would rely on a commitment to train and oversee volunteers it has been assumed for planning purposes that these surveys would be done professionally.) In addition, other invasive plants or new invasions of EWM will always be a concern due simply to boat movement between this lake and others. Therefore, annual boat surveys interspersed with thorough diver surveys will always be HIGHLY recommended for long-term plant management. (Some lake volunteers are using fabricated "glass-bottomed boats" to improve their survey work. Information on these boats can be obtained from Kathy Hamel at Ecology kham461@ecy.wa.gov.).

Cost for the EWM treatment, including the initial and follow-up applications has been estimated at $22,000. There are also costs associated with obtaining the permits and doing post-treatment water quality monitoring. This has been estimated at $1,000. A contingency fund of $2,000 per year should be set aside for follow-up actions and to allow for additional control. Contingency actions (and associated costs) will be dependent upon the extent and location of infestations. A few plants spread out over a small area can be handpulled by divers. Larger infestations that are found in one or two areas may be best controlled by bottom barrier, while larger areas that are spread out through the lake may require spot treatments with Triclopyr.

The other invasive plant that should be controlled immediately is the small patch of fragrant waterlily that is located on the northern shoreline (Figure 1). Currently this is a small patch (~ 50 square feet) that has thus far not expanded noticeably. However, it has the potential to invade the entire littoral zone. The long-term control strategy requires eradication of this plant. The recommended control strategy for eradication of this plant is to use the herbicide glyphosate (Rodeo®) since this is the most cost-effective approach. This should include two applications the first summer followed by a possible last application the following summer or until all the patch is eliminated. Until this plant is eradicated, control of bulrush in the immediate area (within 100 feet of the patch) should not be undertaken, since removing the bulrush could leave openings for further expansion of this plant. This area should be monitored closely for the years following treatment to further insure the plant has been eradicated from the lake. The total cost for eradication of fragrant waterlily is estimated at $600. However, this is based on an assumption that the application would occur in conjunction with other herbicide application activities. Other control activities (hand removal and use of a bottom barrier) could also be effective at eradicating these plants and should be considered as alternatives to the herbicide application. The bottom barrier would be comparatively expensive and would also require long term maintenance and therefore may not be a preferred approach. However, if local SCUBA divers volunteered to hand remove the plants, this might be preferable to the use of the herbicide. This would result in disruption of sediments that may be contaminated with DDT derivatives, but the area impacted (and amount released) would be minimal.

It is possible that a year or so after treatment the decomposing waterlily mat may lift from the bottom and form a floating mat. Due to navigation and other problems lake residents may decide to remove any mats that form. If so, this will require an HPA from WDFW. Collection of lake water samples after the treatment is likely to be required if this work is done through a grant from Ecology. These requirements will be defined in the grant agreement. There are also costs associated with obtaining the permits. Costs for permitting and monitoring associated with glyphosate treatments have been estimated at $1,000.

2,4-D and Glyphosate Use Considerations

Liquid 2,4-D is a relatively fast-acting herbicide that kills the entire plant (systemic herbicide). Its mode of action is primarily as a stimulant of plant stem elongation. A few days after the 2,4-D treatment, observers will see the growing tips of milfoil plants twist and look abnormal. These plants will sink to the sediments usually within one-to-two weeks of treatment. This herbicide is considered to be "selective" for milfoil because it generally targets the broad-leaved plants (dicots) like milfoil. Most other aquatic plants are monocots (grass-like) and are unaffected by 2,4-D.

Water users need to be identified prior to 2,4-D application. Water within the treatment areas cannot be used for drinking until 2,4-D concentrations have declined to the drinking water standard of 70 ppb and water used for irrigation cannot be used until 2,4-D concentrations are 100 ppb or less. Although Roses Lake is not used as a drinking water supply, Lake Chelan is. However, treated water in Roses Lake would need to first move through about ¼ mile of wetland/outlet channel to reach Dry Lake, move through Dry Lake (about 1 mile in length) and then the outlet stream for Dry Lake (another mile) before reaching Lake Chelan. Although the residence time for Roses Lake is not known, it is likely very long (i.e., many years); this means that water movement out of the lake is minimal. Therefore, it is improbable that any herbicide would reach even Dry Lake under these circumstances. Although there are no irrigation withdrawals from Roses Lake, there are two or three irrigated orchards located along the shore. In addition, to the normal posting required for herbicide applications, these orchard owners should be personally contacted to insure they understand what is happening and verify their not using the lake as an irrigation supply especially during the few weeks following treatment. (The herbicide, in its liquid form, can be expected to remain at elevated concentrations in the lake for at least a couple weeks after treatment.)

Permits are required to treat with aquatic herbicides and application must be made by a state-licensed applicator. Permit requirements are currently changing. Typically, the applicator obtains the necessary permit coverage and carries out necessary posting of notices. The community should discuss these requirements with the applicator to insure they are being properly carried out.

The herbicide is available in a granular and liquid form; it is the liquid form that is recommended for use in this plan. Follow-up monitoring of water column concentrations will be required. A few days after the 2,4-D treatment, observers will see the growing tips of milfoil plants twist and look abnormal. These plants will sink to the sediments usually within one-to-two weeks of treatment.

Glyphosate is applied as a liquid spray to the surface of the plants. It permanently kills the plants, but is not selective, that is, it will kill all emergent and floating-leaved plants it comes in contact with. While the herbicide is fast-acting, requiring only about two hours of contact time, its efficiency can easily be affected by waves caused by wind or boat activity that effectively wash off the herbicide before it takes affect. There are water use restrictions associated with use of this herbicide around potable water supply intakes; but these do not apply to Roses Lake. This herbicide breaks down rapidly and is non-detectable within 24 hours. Plants die within a few weeks.

Additional information on both of these herbicides as well as Triclopyr and diquat (two other herbicides that may potentially be used in Roses Lake) is provided in Appendix B & C.

LONG-TERM PLANT CONTROL STRATEGY

The primary native plant that requires control as part of the Long-Term Plant Control Strategy is the bulrush which surrounds the perimeter of the lake, expanding waterward from the shoreline as much as 30 feet in some areas. The long-term plant control needs for the lake include suppressing the bulrush near residential homes and allowing for some control of native plants in this same area, should they reach nuisance levels.

The control strategy for bulrush includes maintaining a 30 to 50 foot wide, “bulrush free” access area for each residential lot. On either side of this bulrush free zone, bulrush would continue to grow but be maintained to an overall width of no more than 5 to 10 feet from shore. The intention of creating this suppression zone is to allow space for a dock, boat access along one side of the dock, and swimming access along the other, while leaving ample vegetation remaining to meet habitat needs. This control strategy would impact only a small portion of the bulrush plant community that exists lake-wide, since there are only a few residential homes primarily concentrated in the south end of the lake. It would represent minor suppression, not elimination of this plant and affect much less than 20% of the shoreline. (The intent is to allow maximum removal of this plant while still falling within the limits of the general HPA permit. Since the provisions of this permit are currently in flux, more specific guidance will be provided to homeowners at the time of application.)This approach would also effectively increase the amount of plant edge along the shoreline. Edge habitat is often more productive in terms of diversity and abundance of species.

It is assumed that most of the removal would be accomplished with the use of the herbicide glyphosate, but physical removal methods might also be applied. Apparently, the bulrush roots lie over native sands. Where this is the case, physical removal methods that involve removing the roots might result in longer-term benefits for lake quality. There is not a great deal of efficacy information for use of glyphosate on bulrush, but the hard cuticle on the stem may affect the effectiveness of the applications. If glyphosate is used, the application should be early in the year before the plant flowers as this may improve effectiveness of the application.

If in the future native plants reach nuisance levels in this docking and swimming areas or in the area of the waterski course, then the herbicide diquat should be considered for periodic (every 2 or 3 years) control. Physical control of the plants (e.g. bottom barrier and handcutting tools) should also be permitted for use in these areas.

The cost for initial removal (two treatment years) of less than 1 acre of bulrush using glyphosate is $600. This cost for native plant control in the residential areas would be covered by participating homeowners. It is recommended that those interested in this control strategy join forces to hire an applicator to treat the entire area at one time. This will result in a more effective and less expensive treatment.

INFORMATION ON OPTIONAL CONTROL MECHANISMS

Information on bottom barriers and trichlopyr is provided here, since these have been identified as potential long term control techniques. Additional information on these and other control techniques is provided in Appendix B.

Bottom Barrier Use

Bottom barriers are manufactured sheets of material that are anchored to the lake bottom to prevent plants from growing; similar to weed barriers commonly used in lawn and garden activities. Several bottom covering materials have been used with varying degrees of success. A woven polyester material such as Texel® is one of the most effective bottom barriers because it is durable and it provides efficient exchange of gas produced from decaying organic matter (roots and other debris). It is typically installed in the winter by unrolling the 15-foot wide sections to the specified length and anchoring them with sand bags spaced 10 feet apart. Bottom barriers should be maintained on an annual basis to ensure adequate coverage and anchoring. Re-installation may be necessary to control encroachment of plants in areas adjacent to dense growth. Bottom barriers can also be fabricated by homeowners from materials such as burlap. The following website should be reviewed for more information:
http://www.ecy.wa.gov/programs/wq/plants/management/aqua021.html

Bottom barriers are effective in deep as well as shallow water and do not have special requirements that eliminate their use in different areas. Control intensity and duration varies depending upon sediment accumulation and encroachment from adjacent area. If properly installed and maintained, bottom barriers can provide a high level of control for five years or more. The primary advantage of bottom barriers is the intense level of control and the ability to be very selective about the control area. The main disadvantage is the high cost per unit area controlled.

For planning estimates it has been assumed that bottom barrier will cost approximately $1.00 per sq. foot installed. Since it is unknown at this time how much bottom barrier might be needed; the cost for this should be covered out of the $2,000 Contingency fund.

Triclopyr

There are two formulations of Triclopyr. It is the TEA formation of Triclopyr (Trade name Renovate3®) that is registered for use in aquatic or riparian environments. Triclopyr, applied as a liquid, is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species such as purple loosestrife. Triclopyr can be effective for spot treatment of Eurasian watermilfoil and is relatively selective to Eurasian watermilfoil when used at the labeled rate. Many native aquatic species are unaffected by Triclopyr. Triclopyr received its aquatic registration from EPA in 2003 and was allowed for use in Washington in 2004. If applied directly to water, a 12-hour swimming restriction has been imposed by Ecology to minimize eye irritation. For the Roses Lake plan this herbicide is recommended as a follow-up spot treatment if the 2,4-D does not eradicate the plants. Its use would be funded from the $2000 contingency fund identified for these efforts.

INVASIVE PLANT PREVENTION AND DETECTION PROGRAM

Over the ten-year implementation period it is hoped that Eurasian watermilfoil will be effectively eliminated from the lake. However, this plant could return to the lake from the introduction of Eurasian watermilfoil fragments transported by boats or even by waterfowl. Other non-native, highly invasive plants of concern include: Parrotfeather (*Myriophyllum aquaticum*), Brazilian Elodea (*Egeria densa*), Hydrilla (*Hydrilla verticillata*), Fanwort (*Cabomba caroliniana*), and Water Hyacinth (*Eichhorinia crassipes*). The focus of control efforts for non-native plants is a prevention and detection program. A contingency plan is also presented in case control of a large area is required.

To be effective this program should include both a source control component and a detection program. The objective of source control is to prevent non-native submerged plants from entering the lake. The public and private boat launches represent areas where there is a high potential for introduction or re-introduction of invasive plants. It is recommended that the lake community institute some public information campaign for opening day of the fishing season and a few other key weekends. Simply having volunteers hand out exotic plant identification cards for a few hours and help with boat and trailer checks will emphasize the importance of the effort and remind boaters of their responsibility to check equipment.

Early detection is the next step to protect against new infestations. While an infestation is still relatively small the options for control are much less expensive. Early detection requires annual surveys to assess the plant community. The main purpose of these surveys is to search for Eurasian watermilfoil and any other exotic plants. However, it will also provide a means for monitoring the native submerged plant community. Professional divers would perform a complete survey every two years, while volunteers would do surveys by boat during the intervening year. (While divers are surveying the lake they can determine whether new infestations can be handled by handpulling the plants or whether, for example, bottom barrier should be installed in a few places to ensure complete control.)

All diver surveys should be done in such a manner as to thoroughly cover the lake bottom between depths of 0 to 20 feet. The survey report should describe the survey method in detail and must include production of a GIS based map that shows the locations of all EWM plants or patches of plants and a calculation of the acreage under each plant type. Actual gps coordinates for all invasive plants identified for control should also be provided.

The primary advantage of controlling small infestations is that it reduces the chance that a large area would need to be controlled by a more intensive and expensive technique. A drawback of controlling small infestations is the high costs associated with diver surveys and hand pulling. A professional diver survey of the entire plant habitat would take approximately 1 day and cost approximately $5,000 (including mapping and reporting). (Costs for hand pulling by contract divers, range from $1,000 to $2,400 per day, depending upon plant type, acreage, and density.) Volunteer divers might also be used for this part of the implementation plan. Depending upon the volunteers used, training in aquatic plant ID may be required which could represent an additional annual cost. For the purpose of this plan and the planning level cost estimates provided, it is assumed that professional aquatic plant surveyors would be used for the first few years after treatment and then on a bi-annual basis after.

The exotic plant control plan complements the plan for the eradication of Eurasian watermilfoil. The surveys that occur every two years would be relied upon to detect new infestations of Eurasian watermilfoil and allow immediate removal of the plants. If Eurasian watermilfoil or another exotic is found, immediate action should be taken and a second dive should be planned for later in the same year to insure there were no surviving colonies. If the area infested is too large to control by handpulling, or if after two follow-up dives the exotic is still found, an appropriate herbicide should be used to eradicate the plant or bottom barrier placed over the infested area.

These additional diver surveys, bottom barrier installation, and herbicide treatments are contingency elements to the overall aquatic plant control plan for the lake. Since these costs would only accrue in the event of another infestation by Eurasian watermilfoil or another exotic plant, the costs could possibly be covered through an "early infestation grant" by the Department of Ecology. However, due to grant uncertainties, a contingency fund has been included as one of the plan cost elements, to help insure protection of the lake.

PLANT CONTROL ADVISORY COMMITTEE

On an annual basis decisions will need to be made about aquatic plant control activities that will require the time and attention of lake residents. Therefore, it is recommended that an aquatic plant control advisory committee be formed. This committee would have the following responsibilities:

- Review annual plant survey information and track potential problem areas. Make decisions on next steps. Next steps might include; contacting an herbicide applicator requesting additional diver time for handpulling, or ordering and installing bottom barrier, etc.)
- Put together requests for bids from herbicide applicators or plant surveyors and select and hire contractors when necessary for tasks such as applying herbicides, and survey and mapping.
- Insure herbicide application permit requirements are met.
- Document plant control activities. Documentation should include information on what activities were implemented each year; how many acres of what kind of plants were controlled; what was used to control them (e.g. what chemical at what concentration, how was it applied and the rate of application) and the costs of the different programs (e.g. surveys and applications).
- Provide information to lake residents and act as spokespeople for answering questions on plant control problems and supporting long-term implementation of this plan.
- It is also helpful if one or two members of the committee train themselves to identify the key invasive aquatic plants of concern in this State, so that lake residents have a resource to take plants to for I.D.
- It may also be beneficial for the committee to monitor boat use during glyphosate applications and ask people to reduce wave development during the 2 to 3 hours immediately following the treatment. This will help improve the effectiveness of the application.
- Lake residents may also want to take charge of personally contacting nearby orchardist's to insure they understand about the herbicide treatments and insure they are not using the lake as an irrigation supply. It is critical this step be taken and talking with the orchardist's will provide another opportunity to involve the community in lake restoration and protection issues.
- Lake residents may also want to implement a volunteer program for completing lake plant surveys. This would involve creating a list of volunteers and organizing a plant identification and survey training workshop and putting together a strategy for completing the surveys.

PUBLIC EDUCATION PROGRAM

The public education program for Roses Lake consists of three parts; the exotic plant prevention plan previously described, lakeside stewardship education, and watershed protection/pollution prevention for protecting the lakes' water quality.

LAKESIDE STEWARDSHIP EDUCATION

Each lakeside resident should be educated about how to reduce the amount of pollutants entering the lake from their property, as well as about things they should do to help retain a complex, diverse, and therefore healthier lake environment. The properties located directly adjacent to the lake have the greatest potential for adversely impacting the lake since pollutants generated on these properties can more easily reach the water.

Lakeside property owners should be provided with information about problems associated with typical urban type landscapes around lake shorelines. This should include information on the drawbacks of using ornamental turf (lawns), and the benefits of adding shoreline plants and diversified lawn plantings, which create habitat structure for birds and wildlife.

Some important considerations for proper stewardship of lakeside property are described here. Informative brochures or newsletter articles should be used to educate lakeside property owners about best management practices (BMPs). Some examples of stewardship ideas include:

- Limit turf and landscaped areas to no closer than 25 feet from the shoreline. Native plants and grasses should be considered for landscaped areas to decrease the amount of fertilizers, pesticides, and other pollutants used.
- Establish a "pollutant free zone" within 50 feet of the shoreline. Try to keep all pollutants; gas for boats, painting projects, landscape fertilizers and poisons, and etc. away from this zone.
- Plant a shoreline buffer of shrubs and tall grasses, preferably native species. This one small activity will cause multiple environmental benefits. If properly designed it will keep geese and other waterfowl from moving onto lawn areas. The vegetation will help filter out pollutants such as fertilizers from landscaped areas before they reach the lake. It will provide protection from shoreline erosion, and it will provide habitat for the many wildlife species that utilize nearshore areas.
- Preserve natural "structure" such as fallen trees and boulders that exists along the shoreline and in the shallow nearshore area. If a tree along the shoreline finally falls in, leave it. Add structure in the form of treetops, twig bundles, and rocks to diversify and naturalize the nearshore area and attract more fish and wildlife.
- Allow emergent vegetation, and other plants to colonize some portion of waterfront area. (This is supported by the bulrush control portion of this IAVMP.)

WATERSHED PROTECTION/POLLUTION PREVENTION

In terms of watershed issues, Roses Lake is fortunate in having a relatively small watershed with no large incoming stream to transport sediments and nutrients into the lake. However, the irrigation ditches and other surface runoff sources although small and spread out can be important pollution sources, as evidenced by the DDT problems.

Since the majority of the lakeshore is not currently slated for development the typical issues associated with shoreline development are not as much of a concern. Nonetheless, lake residents should be aware of the potential impacts of watershed and shoreline development and follow typical shoreline best management practices (BMP's) aimed at curtailing input of nutrients and other pollutants and that allow for shoreline habitat development.

PLAN ELEMENTS, COSTS, AND FUNDING

Table 5 provides a summary of each element identified in this plan and the associated costs. Total cost for the plan for the first ten-year period is estimated at $62,500, approximately $59,100 of which is grant fundable. These costs are based on 2005 cost estimates.

Implementation of the milfoil eradication portion of the Roses Lake Integrated Aquatic Plant Management Plan is projected to occur over a 10-year period. Due to financial constraints it has been assumed that bulrush control and possible long-term nuisance plant control steps will be funded by individual landowners.

Grants

Implementation funding for the eradication of Eurasian watermilfoil, fragrant waterlily, and reed canary grass could be obtained from the Washington State Department of Ecology (WDOE) Aquatic Weed Management Fund (AWMF) grant program. The AWMF grant program funds a variety of aquatic plant management projects statewide. Grants are awarded annually on a competitive basis. Local jurisdictions are eligible to compete for these grants. No one jurisdiction can be awarded more than $75,000 annually. The grants require a 25% match; thus to get the entire $75,000 would require $25,000 in matching funds for a total of $100,000.

Due to the small number of people who live on this lake and the lack of financial support from local agencies, collection of funds to meet the match requirements is the limiting factor to obtaining a grant. Control options were designed with the assumption that the maximum grant value would be $55,000 with $13,750 in matching funds. This level of grant funding would be expected to cover the first 8 years of implementation.

NOTE: The cost for eradication is likely to increase dramatically with time as the milfoil invades a greater share of the lake. It is critical this plan be implemented soon. Little financial assistance can be expected from local agencies; therefore, the cost per land owner (for in-kind contribution) will become prohibitive if more acreage is involved. For these reasons it should be a high priority to obtain immediate grant funding.

Table 5. Estimated Cost for Implementation of the Roses Lake IAVMP. (Costs shown in Bold are grant fundable.)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Immediate Control Strategy											
Milfoil Eradication	**9000**	**4500**	**4500**	**2000**	**2000**						**$22,000**
Waterlily Eradication	**300**	**300**									**$600**
Pre-Treatment Survey & Map	**5000**	**5000**	**5000**								**$15,000**
Permit and Monitoring Costs			**$1,000**								**$1,000**
Contingency						**2000**	**2000**	**2000**	**2000**	**2000**	**$10,000**
Long-term Control Strategy											
Bulrush Suppression	300	300			1000			1000			$2,600
Diver Surveys					**3500**		**3500**		**3500**		**$10,500**
Boat Surveys (Volunteers)				0		0		0		0	$0
Nuisance Plant Control						400			400		$800
Total Cost	**$14,600**	**$10,100**	**$9,500**	**$2,000**	**$6,500**	**$2,400**	**$5,500**	**$3,000**	**$5,900**	**$2,000**	**$62,500**
Grant Fundable Cost	**$14,300**	**$9,800**	**$9,500**	**$2,000**	**$5,500**	**$2,000**	**$5,500**	**$2,000**	**$5,500**	**$2,000**	**$59,100**

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Lake Management Districts

A lake management district (LMD)or other special taxing district has not been recommended as a funding strategy for this lake due to the few property owners who live on the lake and the likelihood that a LMD would not be approved. The following information is provided for reference.

A lake management district is a locally defined special assessment used to raise revenue to implement lake protection or improvement activities. Property owners on or near a lake pay a special charge on their property, either annually or on a one-time basis. A LMD can be formed for up to a 10-year period. LMD's have been formed and operated successfully in a number of counties in the State.

Section 36.61 of the Revised Code of Washington (RCW) describes the process for LMD formation. According to the law, an LMD can be initiated through a petition to the City or County Council by property owners of at least 15 percent of the acreage within the proposed LMD boundary or by the Council who can adopt a resolution of intention. The petition or resolution of intention needs to include the following information: (1) proposed lake protection or improvement activities; (2) total amount of money to be raised; (3) whether money will be collected annually or one-time only; (4) amount of assessment (one-time or annual); (5) duration of LMD; and (6) proposed LMD boundaries.

After the petition is adopted or the resolution of intention is passed, a public notice is sent and a public hearing is held. This is followed by a special election in which each property owner has one vote for every dollar of proposed assessment. The proposed LMD must be approved by a simple majority of the votes cast. If there is a positive vote, the Council adopts an ordinance to create the LMD. If there are no appeals, the Assessor prepares a special assessment roll, which lists each property and the proposed special assessment. There is a second public hearing at which individuals can raise objections to the amount of the special assessment. The Council may revise the special assessment roll in response. Then the special assessment roll is confirmed and billing can proceed. The money is administered by the City or County but a community-based advisory board can be appointed by the Council to oversee the project expenditures.

There are also other ways of funding lake activities, such as through Special Purpose Districts (e.g. Water and Sewer Districts and Flood Control Districts). These are developed and operated under a different set of rules than LMD's, but may be a more effective means of collecting funds especially if a Special Purpose District already exists in the area.

IMPLEMENTATION AND EVALUATION

The following details a step-by-step approach to implementation of this plan:

Step 1) Set up a Plan Implementation Committee

The first step to implementing the plan is to set up an organization or committee that will take responsibility for it. The lake community will control how and whether the plan is implemented. Many of the tasks this committee will need to carry out are described in the plan under the "plant control advisory committee" section.

Step 2) Apply for a Plan Implementation Grant

Grants for up to $75,000 are available through the WDOE Aquatic Weeds Program for implementation of approved Aquatic Plant Management Plans. Lake residents should continue to work through Chelan County to apply for these grant funds. Applications are due by the end of October.

Step 3) Spring 2006 Diver Survey

A contractor should be hired to complete a diver survey in the spring of 2006 and provide a map with gps coordinates. The results from this survey should be provided to the selected herbicide applicator within two weeks of the application. It is recommended that surveys be completed by a firm not affiliated with the herbicide applicator.

Step 4) Select herbicide applicator

A bid should be prepared and an applicator selected for both the 2,4-D application and glyphosate applications. This may require working with landowners ahead of time to obtain a list of those wishing to participate in the bulrush treatment. The bid should be prepared for release by April of 2006, allowing two weeks for bidders to respond. The bid should include preparation of permit applications and application costs, as well as all notification and posting requirements associated with the applications. Herbicide application should be scheduled to occur by late June.

Step 5) Collect water samples for analysis

If a grant agreement is acquired from Ecology for implementing this plan, there will be monitoring requirements associated with the herbicide treatments. This is likely to entail collecting and mailing a few water samples the day following treatments; but may include more than this. This monitoring can be done by lake residents and should not be done by the applicator. The results should be reported to Ecology; all of which should be defined in the grant agreement.

Step 6) Follow-up surveys

A post treatment diver evaluation survey should be done within one month of the 2,4-D application. A revised map and report clearly delineating the impacts from the herbicide treatments should be made with recommendations on follow-up treatments or other contingency activities (e.g., hand removal etc). Again, it is recommended that evaluation surveys be done by a firm not affiliated with the applicator.

Step 7) Conduct Annual Evaluation

Complete a written annual evaluation for the lake associations records that describe what elements of the plan have been implemented, relate the existing plant community to established goals, and makes recommendations for the next year's activities.

It is important that there is some mechanism in place for periodic evaluation of this plan and determination of whether it is meeting stated goals or whether the goals have changed. This evaluation should be done on a yearly basis. It should begin with a description of which elements of the plan have been fully implemented, which have not, and why. It should also include a summary of the plant monitoring results, both those obtained by volunteers and those by professionals. These results should be used to aid in the determination of whether goals have been met. The community should also be asked for input on their satisfaction with plant conditions. For example, it is possible that the goals will be met, but that some people will remain dissatisfied. Although it is unlikely that everyone's needs will be met, an effort should be made to track concerns, especially if they are widespread. This information should be used to decide on the following years activities; does an herbicide treatment need to be scheduled? Has there been a re-infestation of Eurasian watermilfoil? Have any other invasive plant been identified? Do handtools need to be purchased? Is it necessary to implement the back-up or contingency plan? Over the long-term, adequate annual evaluations can make the difference between project success and failure.

Step 8) Institute a Long-Term Plant Monitoring Program

Develop a list of lake volunteers and divers interested in conducting annual aquatic plant surveys. Develop a plan for training volunteers, doing the surveys, and handling and reviewing information. Contact professional aquatic plant experts for conducting bi-annual surveys.

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REFERENCES

Carlson, R.E. 1977. *A trophic state index for lakes*. Limnol. Oceanogr. 22:361 - 368.

Gilliam, R.J. and G.C. Bortleson. 1983. *Relationships between water quality and phosphorus concentrations for lakes of the Puget Sound region.* U.S.G.S. open file report 83-255.

LCRD 1998. Water Quality Trends and Characteristics of Agricultural Drains. Lake Chelan Reclamation District. 1998.

LCRD 2004. Manson Lakes Water Quality Assessment: Lake Trophic Status and DDT and Phosphorus Load Evaluation. Lake Chelan Reclamation District. July 30 2004.

Steele, Robert. WDFW Eastern Region. Personal Communication. 5 December 2005.

Turner, Scott. WDOE Yakima Office, Personal communication: August 2005.

USFWS 2005. Wetlands Online Mapper. U.S. Fish and Wildlife Service. August 2005.

Viola, Art. WDFW Eastern Regional Habitat Biologist, Personal communication: August 2005.

WDFW 2005a. Washington State Department of Fish and Wildlife. *Spring 2005 Hatchery Trout Stock Plan for Washington Lakes and Streams*, March 2005.

WDFW 2005b. Washington State Department of Fish and Wildlife. *Washington Fishing Prospects County-by-County*. 2005. Available online.

WDFW 2005c. Washington State Department of Fish and Wildlife. Habitats and Species Maps, September 2005.

WDNR 2005.Washington State Department of Natural Resources. Washington Natural Heritage Information System, September 2005.

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APPENDIX A

RECORD OF PUBLIC MEETINGS

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ROSES LAKE
ASSOCIATION

May 12, 2005

Hello to all,

I wanted to take a moment to update everyone on the status of the development of the Integrated Aquatic Vegetation Management Plan (IAVMP) for Roses Lake, as well as to invite you to attend an upcoming public meeting.

In review, the Department of Ecology offered a grant to Chelan County to fund the development of an Integrated Aquatic Vegetation Management Plan (IAVMP), with the eventual goal of eradicating milfoil in Roses Lake. There was a 25% matching fund requirement that Chelan County was unable to fund. The Roses Lake Association, a non-profit corporation, subsequently entered into an Interlocal Cooperative Agreement with Chelan County, and thanks to the generous donations from 12 families as well as a significant donation from the Public Utility District, the Association provided the matching fund amount needed to obtain the grant.

A vendor (Envirovision) for the IAVMP was selected through a competitive bidding process, and a Contract and Scope of Work for the IAVMP was developed and approved by the Association, Department of Ecology, and Chelan County.

The next step in this process is to hold a public meeting to discuss the IAVMP planning. **This meeting is scheduled for Sunday, May 29 at 1:00 p.m., and will be held at the Chelan County Fire District #5 fire station, located at 2010 Wapato Lake Road, Manson.** Joy Michaud, representing Envirovision will be present at the meeting to provide an overview of the IAVMP planning process and purpose, as well as to discuss plan components and develop and prioritize a list of goals. A steering committee will also be selected during this meeting. An announcement of this public meeting is being posted in the legal notices sections of two local newspapers, the Chelan Mirror and Wenatchee World.

I am sad to report that Drew Nielsen will no longer be able to continue his participation with the Association. Drew's family is dealing with a serious medical situation, and he will need to turn his full attention to that matter. Our thoughts and prayers go out to him and his family.

I look forward to seeing you at this meeting and progressing with the planning process. Please feel free to call me at (425) 407-0850 or send email to: roseslakeassoc@aol.com, if you have any questions.

Thank you,

Richard Langford

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Hello to everyone:

On Sunday May 29, 2005 at 1pm, the Roses Lake Association will have a meeting to discuss the planning of the milfoil eradication in Roses Lake. Joy Michaud, representing Envirovision will be there to help direct the planning process. This meeting is open to the public. A steering committee will be selected to aid in the project . The meeting will take place at the fire station on Wapato Lake Road. The address is 2010 Wapato Lake Rd. Below is a tentative agenda for the meeting. Please come if you can.

Richard Langford, Roses Lake Association President

ROSES LAKE ASSOCIATION
AGENDA IDEAS FOR PUBLIC MEETING #1

Introduction and Overview - Summary of agenda - Steps taken to get here (history) - Consultant selection process - Introductions - Meeting groundrules, sign-in etc	Rich	10 minutes
Overview of IAVMP Planning Process and Purpose	Joy	10 minutes
IAVMP Plan Components	Joy	5 minutes
Develop Problem Statement w/group	Joy	15 minutes
Develop and Prioritize List of Goals	Joy	30 minutes
Overview of Plant Control Methods	Joy	20 minutes
Next Steps/Schedule	Joy	5 minutes

Steering Committee Selection
- Describe their responsibilities for IAVMP development
  o Review contracts if necessary
  o Review reports
  o Attend at least 3 meetings
  o Communication with lake residents
	Rich	10 minutes

Q&A/Closing	Rich	5 minutes

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Moses Lake

SIGN-IN SHEET

May 29, 2005

NAME	PHONE	EMAIL	ADDRESS
Rich + Denise Langford	425.407.0850	AWR1211@comcast.net	2602 59TH ST SW Everett, WA 98203
Erik Liddiatt	360 794-4749	eliddiatt@comcast.net	12623 264th Ave SE Monroe, WA 98272
Jamie & Silva	360) 794-4197	jleesilvA@comcast.net	14317 253 Ave SE Monroe WA 98272
Karlene Mar	509 687-3221	jerryvmartm@msn.com	PO Box 442 Manson
Jeff Conwell	425.218.3669	jconwell@verizon.net	2328 202ND ST SE Bothell, WA 98012
Bill Corney	360 435 3204		25319 70th Ave. NE Arlington WA 98223
Les Russell	(253) 686-1281		P.O. Box 73156 Puyallup, WA 98373

Check marks are for steering members.

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SIGN-IN
ROSES LAKE

Envirovision

Name	Project	Date 25 Sept 05
Subject		Ph. #

	Name	Phone
	Joy Michaud	360-754-1344
greenmamba04@yahoo.com	David & Heidi Copeland	206.706-3036
DNR1211@comcast.net	Rick Langford	425-407-0850
SK3185@Juno.com	Chuck & Sandy Brooks	360 435-3185
	Jim Wright	687-6050
JERRYVMARTIN@MSN.COM	Jerry L. Martin	687-3221
JCONSWELL@ALLSTATE.COM	JEFF CONWELL	425.218.3669
	Bill Carney	360-435-3204
VSONSeQwest.net	Greg & Landy Vornbrock	206-937-3723

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APPENDIX B

AQUATIC PLANT CONTROL METHODS
&
SUMMARY OF APPLICABILITY

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INTRODUCTION

The IAVMP developed for Roses Lake is primarily focused on the eradication of Eurasian watermilfoil and fragrant waterlily; although suppression of bulrush in some of the nearshore zone and possible long-term control of nuisance plants are also project components. The information in this Appendix was developed to provide a summary of aquatic plant control methods considered in development of plans for achieving these goals and a statement of their applicability to Roses Lake management issues. Much of the information in this appendix is excerpted from A Citizen's Manual for Developing Integrated Aquatic Plant Management Plans (WDOE 1994), the Supplemental Environmental Impact Statement for the Department of Ecology's Aquatic Plant Management Program (WDOE 2001), and the Department of Ecology's Aquatic Plants and Lakes website: www.ecy.wa.gov/programs/wq/plants/management/index.html.

PLANT CONTROL TECHNIQUES

No-Action Alternative

The IAVMP planning process is based on the premise that some action should be taken to meet the goals set by the lake users. However, it is possible to take "No Action" and the impacts of this alternative should be examined to further define the long-term consequences of not implementing an aquatic plant management plant while also serving as a reference against which other control techniques can be compared.

If No Action is taken to eradicate or greatly control the Eurasian watermilfoil it can be expected to colonize the entire littoral zone of the lake; often resulting in an extension of the submerged plant zone to a an even greater depth of 20 feet. The State and Nation-wide case histories of this plants' growth habit leave little doubt as to this eventuality. The result is a monotypic stand of very dense aquatic plants that grow and mat even the lake surface. For Roses Lake this could represent over 45% of the lake surface area. Any type of boating in this area, whether for fishing, boating, skiing, canoeing etc) becomes very difficult and access to the open water where these activities might still occur is also difficult. Swimming (an activity that occurs almost always in the littoral zone) is greatly reduced and may even be considered hazardous. Excessive aquatic plants also influences water quality by causing more pronounced temperature stratification and potentially a reduction in water circulation. Chemical parameters such as pH, alkalinity, and dissolved oxygen may also be impacted through alteration of biological processes such as photosynthesis, respiration, and decomposition.

Dense stands of aquatic plants have been shown to result in low oxygen levels that are detrimental to fish and likely other aquatic organisms. Aquatic edge habitat is reduced and there is less complexity and diversity of plant habitat. These impacts would result in degradation of the lake fishery. Overall the result is a loss of beneficial use by most organisms that have typically used Roses Lake, and a critical loss in aesthetic enjoyment. Although supporting literature is not readily available to assess impacts of these changes to wildlife, it is likely that the change in habitat structure would affect use of the lake by such things as diving ducks and turtles.

Although the above description has focused on impacts from continued invasion by Eurasian watermilfoil, the colonization of the nearshore area by fragrant waterlily would result in similar habitat changes and more limitation of beneficial use.

Advantages of No-Action alternative:
- no treatment cost
- easiest to implement
- potential long term consequences, although negative, imply no personal or agency risk

Disadvantages of No-Action alternative:
- quality of the lake will continue to decline,
- recreational opportunities will decline,
- fish and wildlife habitat will be reduced or impaired,
- property values may decline
- probable acceleration of lake filling process.

Preventative Tools

Controlling the input of nutrients such as nitrogen and phosphorus into the lakes may aid in limiting the growth potential of aquatic plants (including algae). Certain preventative measures to control the input of these nutrients into the lake should be considered. Most of these preventative measures are described as Best Management Practices (see Lake Stewardship section presented earlier).

Watershed and Shoreline Controls: There has been no large-scale study of Roses Lake that can be reviewed to assess the possible influence of watershed controls on lake water quality. However, the lack of a true surface inflow and the small area of the watershed reduce the potential influence of the watershed on the lake. However, the irrigation ditches and other subsurface flows do deliver nutrients and other pollutants to the lake.

The primary long-term watershed concern is development of the shoreline. The current lack of development along the shore means that the potential for impact over the long term is high. Lake stewardship practices such as described in this IAVMP should be considered for long term protection of the lake.

Advantages of Watershed and Shoreline Controls:
- lessen the amount of nutrients entering the lake,
- lowers the potential for excessive sedimentation and erosion,
- provides more diverse, complex shoreline habitat,
- may provide ecological benefits to areas beyond the lake.

Disadvantages of Watershed and Shoreline Controls:
- can not be regulated effectively
- not understood or valued by property owners

Costs of Watershed and Shoreline Controls:

- none associated with this landowner education approach

Application for Roses Lake Aquatic Plant Management:
Although there is value to these programs for all lakes for long-term management, these controls would not in any way decrease, control or affect the existence or continued colonization of Eurasian watermilfoil.

In-Lake Nutrient Controls: The reduction in the availability of nutrients already present in the lake as a means of limiting algae and aquatic plant growth is a legitimate approach. However, only approaches that limited nutrients available through the sediments (dredging) would be useful for controlling aquatic plants. Sediment dredging is far too expensive to be considered as a common lake protection or restoration technique. Disposal of the dredged sediments which may be contaminated from past DDT usage would drive up disposal costs tremendously.

Public Awareness and Involvement Program: Lakeside and watershed residents should be informed of all aspects of aquatic plant, algae, and nutrient management. Their understanding of these management issues is critical to the long-term success of this plan. It is strongly recommended that a public education and awareness program be a major component of any management plan. This program would serve to keep residents informed of past, current, and future lake management activities and aid in promoting lake stewardship. The residents should also be made aware of changes in the plan should they be necessary, as well as assessing the effectiveness of current management activities. For this very small lake community, discussions of proper stewardship and results from lake management activities should be discussed at annual RLA meetings.

Lake and watershed residents should be supplied with information such as; tips on how to identify common aquatic plants, control of nutrients before they enter the lake (e.g. curbing fertilizer use on water-front property), simple aquatic plant control measures that can be employed by individual homeowners, and regulations governing such activities.

In general, lake and watershed residents gain satisfaction and a sense of ownership when they are directly involved in lake management activities. Therefore, public participation should be a key component of any lake management plan. Direct participation may take place through volunteer surveys and data collection, organization of meetings, and dissemination of materials related to lake management.

Advantages of a Public Awareness and Involvement Program:

- allows for more informed lake management decisions by stakeholders,
- potentially builds public support for proposed activities,
- involves lake and watershed residents in the decision-making process.

Disadvantages of a Public Awareness and Involvement Program:

- public must be committed to implementing plan and maintaining long-term continuity.

Costs of a Public Education and Awareness Program:
- variable depending upon approach

Application for Roses Lake Aquatic Plant Management:
Although public education programs are useful tools to improve long-term management of the lake, they can not affect the existence or continued invasion of Eurasian watermilfoil or other aquatic plants. Public education is an important component of the Prevention and Detection program described in the IAVMP.

Physical Controls
Physical control techniques encompass most manual or mechanical efforts that remove, cover, shade or desiccate all or some portion of the targeted aquatic plants.

Hand Removal: This control technique is generally accomplished by digging or pulling aquatic plants and is similar to weeding your garden. In shallow waters residents can remove the plants by hand and/or by using hand-held gardening tools. In deeper waters ($\geq$ 3 feet) SCUBA divers can be used to hand remove plants. All plant materials are collected and placed in a bag for proper disposal on shore.

The effectiveness of this plant control technique is mainly a function of sediment type, visibility (water clarity), plant type, and the thoroughness in which the plants are removed. The duration of plant control mainly depends on the variables above and may last from weeks up to multiple years.

Advantages of Hand Removal:
- immediate clearing of the water column,
- can selectively remove targeted plant species,
- is an effective control option around docks, rafts, and boats,
- Equipment is inexpensive.

Disadvantages of Hand Removal:
- technique is time consuming and labor intensive,
- may have delay in removing plants due to disturbed sediments and therefore low visibility
- use of SCUBA divers in deeper waters more costly,
- may not be feasible in areas of dense plant growth,
- some plant species difficult to remove

Costs of Hand Removal:
- no cost if performed by volunteers,
- $1,500-$2,500 per day for two divers and a support boat & operator,

Application for Roses Lake Aquatic Plant Management:
The size of the milfoil beds preclude the use of hand removal as the primary tool. This method is appropriate as a control mechanism after initial treatment has been done to minimize the areal extent and number of Eurasian watermilfoil plants. This method could be effective for the

removal of Fragrant Waterlily, as the infested area is only about 50 sq. ft., but the costs are very high for a professional diver service to remove the plants.

Bottom Barrier Installation: Bottom barriers are essentially "underwater blankets" that cover the bottom sediments and the plants growing there. These barriers are made of many different materials. This list includes: burlap, sand-gravel, plastics, perforated black Mylar, and a material called Texel, which is specifically manufactured for aquatic plant control. These bottom barriers cover the bottom sediments and 1) kill the plants growing there, and 2) prevent new plants from becoming established. Although bottom barriers are mainly a small-scale control technique, they can be highly effective and provide long-term control.

Given enough time, almost all of these materials will trap pockets of gasses due to decomposition of organic material under them. When this occurs, many bottom barriers "balloon" upward, and become less effective and potentially hazardous to lake users. Therefore, it is important to properly anchor bottom barriers to the bottom, preferably using native materials such as rocks or sandbags. Bottom barriers should also be inspected periodically for sediment buildup and/or gas buildup. Periodic inspections also indicate if the materials being used need to be replaced, especially those that decompose (e.g. burlap).

Bottom barriers will control most aquatic plants but will not provide relief from freely floating plants such as coontail (*Ceratophyllum demersum*). Other plants such as Eurasian watermilfoil may be able to form a canopy over the bottom barrier by putting out lateral shoots around the edges of the material, eventually growing up and over the barrier. Moreover, obstructions such as logs, rocks, and steep topography may inhibit the use of bottom barriers in some areas.

Bottom barriers can be installed by homeowners or by SCUBA divers depending on local conditions. The optimal time to install bottom barriers is in late winter or early spring before plants are growing rapidly. This minimizes the amount of gas that could potentially build up under the barrier due to decomposition of organic matter. If bottom barriers are to be used in areas of dense plant growth, it is advisable to cut and remove as much vegetation as possible prior to installation.

Advantages of Bottom Barriers:
- immediately creates an area of open water,
- relatively simple to install in swim beaches and around docks,
- controls 100% of plants where they are used,
- effective in targeting patches of plants too large to cost-effectively remove by hand.

Disadvantages of Bottom Barriers:
- high cost makes them cost effective only on a small scale,
- require periodic inspection, maintenance, and replacement
- may be a safety hazard to lake users if not maintained properly,
- will kill all plants in areas where used,
- may negatively impact many bottom-dwelling organisms and eliminates fish spawning in immediate area,

Costs of Bottom Barriers:
- $0.35 to $1.25 per square foot for materials
- approximately $0.75 per square foot for installation
- $100 - $200 for annual maintenance

Application for Roses Lake Aquatic Plant Management:
The size of the milfoil beds preclude the use of bottom barrier as the primary tool. This method is appropriate as a control mechanism after initial treatment has been done to minimize the areal extent and number of Eurasian watermilfoil plants. Bottom barrier may be used to control small areas of plants or new infestations. Bottom barriers have also been shown to be an effective method of treatment for Fragrant Waterlillies. Considering the size of the existing waterlily community in this lake, this method is applicable, however, more expensive than the herbicide application.

Water Column Dyes: To use this aquatic plant and algae control method, water-soluble colored dyes are added to the water column to suppress plant and algae growth. The dyes reduce the amount of sunlight available to plants and algae, and therefore inhibit photosynthesis. The dyes are formulated to absorb segments of the electromagnetic spectrum (light) that are optimal for photosynthesis. The use of water column dyes is limited to lakes or ponds with higher retention times (low flushing) and have relatively clear water.

Advantages of Water Column Dyes:
- cost is low and no special equipment required,
- not toxic to humans, other wildlife using the water,
- may control both aquatic plants and algae.

Disadvantages of Water Column Dyes:
- may suppress both aquatic plants and algae,
- suppression may not be adequate to achieve goals
- does not eradicate noxious plants
- is less efficient when plants/algae at water surface,
- low water retention time may reduce effectiveness,
- may need to consider outflows and water rights of residents.

Costs for Water Column Dyes:
- $12.00 to $15.00 per acre foot.

Application for Roses Lake Aquatic Plant Management:
This control method is not appropriate due to its lack of specificity to Eurasian watermilfoil and low expected efficacy on aquatic plants. The waterlillies would not be significantly affected by dyes, since their leaves are at the water surface.

Sediment Removal: Removal of lake sediments controls aquatic plants primarily by reducing the available habitat where plants can grow by deepening the water body. This is most relevant for bottom-rooted aquatic plants. Sediment removal may also indirectly limit aquatic plant growth through removal of nutrients in the sediment, which are available to bottom-rooted plants. Sediments accumulate in a waterbody from many sources, including: stormwater drainage, surface water runoff, stream inflows, and erosion. Shallow lake and ponds often have abundant communities of aquatic plants. These plants accelerate the accumulation of sediment by trapping particles and through their annual senescence and decomposition.

Several different types of mechanical equipment are used to remove sediments from lakes. Some of these include: backhoes, drag lines, suction vacuums with pumps, and many other pieces of auxiliary support equipment used to de-water and transport materials. Settling ponds are often constructed to de-water sediments as transport of water-laden materials is very expensive. Extensive studies and testing are required prior to initiation of this control method. Several permits are also required, including one from the US Army Corps of Engineers.

Advantages of Sediment Removal:
- can be a long-term solution to suppress both aquatic plant and algae,
- decreases available plant habitat and potentially reduces amount of in-lake nutrients.

Disadvantages of Sediment Removal:
- extremely costly,
- may require several years to acquire permits,
- shoreline access for equipment and noise often a problem,
- may take multiple years to complete the operations
- disturbance of benthic organisms and fish spawning habitat,

Costs for Sediment Removal:
- $400,000 to $600,000 for design, inspection, environmental monitoring,
- overall project cost typically in the millions of dollars.

Application for Roses Lake Aquatic Plant Management:
This control method if aimed at the littoral zone of the lake is considered appropriate for control of aquatic plant habitat. There are several problems with this method though. The sediments in this lake may be contaminated with breakdown products of DDT from previous use by neighboring orchards. Disturbance of these sediments could expose contaminated sediments and lead to release of the pesticide into the water. It is also cost prohibitive.

Water Level Drawdown: Water level drawdown is most commonly used in reservoirs for power generation, flood control, or irrigation. During drawdown, water is either pumped or drained out of a system. The low water levels often expose aquatic plants that are then subjected to desiccation and/or freezing. Plants that do not have over-wintering structures such as turions or tubers often are more severely impacted. In some instances, plants that are not completely killed exhibit stunted growth after the water level is restored. The level of plant control is mainly a function of how low the water is drawn down, the length of time water is at a low level, and the average temperatures to which they are exposed during drawdown.

Advantages of Drawdown:
- may already be a scheduled activity to accomplish other objectives (e.g. power generation),
- often little or no cost
- no chemical/herbicide concerns

Disadvantages of Drawdown:
- short-term loss of beneficial uses (e.g. boating),
- impacts bottom-dwelling organisms and spawning habitat,
- lake morphology and climate may reduce effectiveness
- not all problem plants are affected,
- is not effective at eradication of a noxious plant.

Costs of Drawdown:
- variable.

Application for Roses Lake Aquatic Plant Management:
There is no existing mechanism (dams and pumps) for lowering the water level for Roses Lake, therefore the cost for implementation would be high. Further, the lake is used extensively for ice fishing therefore a winter period drawdown would impact this important beneficial use. This method might curtail plant growth but ultimately would not affect the long term existence or increased colonization by Eurasian watermilfoil.

Mechanical Controls

Hand Cutting: Hand cutting aquatic plants is accomplished by using a "cutting rake" to cut the plants below the surface. Most often the above-sediment portion of the plants are cut while leaving the roots behind. Some of the different "cutting-rakes" used are; scythes v-shaped rakes with a cutting edge, or thin cables. Often these tools have handles with a rope attached. The cutter is thrown out into to the water and retrieved to the shore, dock, or raft.

Advantages of Hand Cutting:
- equipment costs are minimal,
- requires no special training,
- provides immediate control,
- can be used around docks, boats, or rafts.

Disadvantages of Hand Cutting:
- not appropriate for milfoil control in partially infested lakes because it enhances milfoil spread
- time consuming, labor intensive,
- often required several times throughout the growing season,
- should collect all plant fragments and dispose of on shore.

Costs of Hand Cutting:
- equipment costs typically $50 to $1000
- no labor cost unless contractor hired

Application for Roses Lake Aquatic Plant Management:
Due to the increase in plant fragments from cutting, this is not an appropriate tool for use in lakes where milfoil has not already colonized the entire littoral zone. This method would not be cost effective for the small amount of Waterlily, and would not effect the tubers or roots, allowing for continuous plant growth.

Mechanical Harvesting: Mechanical harvesting is a control technique that is essentially mowing plants and collecting them to be disposed at on offshore location. Harvesters have blades that cut plants from 3-8 feet below the water and then move them up onto a conveyor belt and onto the machine. To offload the cut material, the harvester reverses the direction of the conveyer belt and transports the material to a truck on the shore. The truck then disposes of the material at a pre-determined location. A typical mechanical harvester may cut up to 2 acres per day. The amount of material that these machines can harvest is mainly limited by the time it takes to travel to the truck on the shore and offload the material.

Although mechanical harvesters can remove most of the aquatic vegetation in the areas in which they are working, they inevitably allow some of the cut material to escape. Also, simply cutting the upper portions of the plants does not inhibit their continued growth. Most harvesters only control plants for a few weeks up to a few months. Mechanical harvesting is not species-specific unless the harvester is used in an area that is basically a monoculture of a particular plant species. Due to the potential to produce many plant fragments, mechanical harvesting is not recommended for waterbodies with early or low-density infestations of Eurasian watermilfoil. Mechanical harvesting also contributes to a significant mortality of small fish and invertebrates.

Advantages of Mechanical Harvesting:
- immediate removal of plants,
- no water use restrictions during operation,
- plant material may be used as a soil amendment.

Disadvantages of Mechanical Harvesting:
- not appropriate for milfoil control in partially infested lakes because plant fragmentation may actually enhance growth time consuming, limited by availability of sites to offload vegetation,
- equipment intensive, maintenance may slow operation,
- usually must be repeated several times throughout the growing season,
- plant fragmentation may actually enhance growth,
- not species-specific,
- negative impacts to invertebrates and small fish,
- may actually release more nutrients through agitation of sediment and plant leaching than through removal of biomass
- high capital costs for machine purchase or use by management consultant

Costs of Mechanical Harvesting:
- $750 to $1500 per acre for contract commercial aquatic plant harvesters,
- $100,000 to $180,000 for harvester/off-loader purchase,
- cost of disposal is highly variable.

Application for Roses Lake Aquatic Plant Management:
Due to the increase in plant fragments from cutting, this is not an appropriate tool for use in lakes where milfoil has not already colonized the entire littoral zone. The high cost and need for repetitive cutting also make this an impractical option.

Rotovation: This plant control technique involves the use of a large underwater rototiller. Unlike mechanical harvesters, Rotovators dig down into the sediment seven to nine inches and grind up the lake bottom. This dislodges and plants and roots crowns. These plants then typically float to the surface. Mechanical harvesters may then be used to collect the plant material and transport it to shore for disposal. Rotovation provides for longer term control (1-3 years) than mechanical harvesters (weeks to months). Rotovation is not an effective option in areas with pioneering infestations of noxious plants that spread primarily by fragmentation. Also, rotovation is only effective on rooted aquatic plants and would not work well on freely-floating plants.

Advantages of Rotovation:
- provides longer control than mechanical harvesting,
- may stimulate growth of desirable native plants,
- removes entire plant including roots,
- in some instances can be used year-round.

Disadvantages of Rotovation:
- not appropriate for milfoil control in partially infested lakes because plant fragmentation may actually enhance growth time consuming, limited by availability of sites to offload vegetation,
- expensive with high maintenance costs,
- destroys habitat for bottom-dwelling organisms and fish,
- temporarily reduces water clarity, releases nutrients from sediment,
- need to check for underwater utilities.
- There is no known rotovator equipment available in Washington State making it a very difficult strategy to implement. (This is likely a function of its cost and other disadvantages.)

Costs of Rotovation:
- $1,500 to $2,000 per acre.

Application for Roses Lake Aquatic Plant Management:
Due to the increase in plant fragments from cutting, this is not an appropriate tool for use in lakes where milfoil has not already colonized the entire littoral zone. This would also greatly disturb the sediments, resulting in release of the buried DDT derivatives.

<u>Diver Dredging</u>: Diver dredging is a plant control method where divers use suction hoses to vacuum plants up from the lake bottom. The vacuum suction is caused by the operation of small pumps on a surface boat. The SCUBA divers dig up or pull the plants from the lake and feed them into the suction hose. On the barge, plant material is trapped by a screen and water is returned to the lake.

This plant removal technique is more effective when removing plants in areas of loose sediment. This allows for easier removal of the plants, whereas plants rooted in hard sediment are more difficult to dislodge. However, in areas of loose sediment, visibility can be reduced by disturbing the lake bottom. This technique is best applied in areas with low levels of the plant(s) species to be removed. Although a screen collects the plant material, fragmentation of plants is also an issue.

It is inevitable that the discharge water from the surface boat will be cloudy from sucking up sediment. This temporarily reduces water clarity and may fuel plant and algae growth through nutrient release. Sediment curtains are sometimes used to mitigate the drift of disturbed sediments, but there is no practical means to minimize nutrient release.

Advantages of Diver Suction Removal:
- useful in selectively removing target species,
- may be used in and around docks, boats, and other nearshore areas,
- feasible in areas where herbicides not an option.

Disadvantages of Diver Suction Removal:
- expensive, labor intensive, and relatively slow,
- not appropriate for milfoil control in partially infested lakes because plant fragmentation may actually enhance growth time consuming, limited by availability of sites to offload vegetation,
- disturbs the bottom, releases nutrients,
- large rocks, logs, etc. may further reduce cost-effectiveness.

Costs of Diver Dredging:
- $1,500 to $2,500 a day (includes divers and support personnel).

Application for Roses Lake Aquatic Plant Management:
Due to the high cost, this is not appropriate for use at this scale. This method could also cause the release of buried DDT derivatives through the disturbance of lake sediments and their spreading throughout the water column.

Biological Controls

The biological control of an aquatic plant problem focuses on the selection of organisms that have an impact on the growth of a target plant. By stocking a lake with these organisms or "agents", the population of the target plant can be reduced and native plants can recover. Although there have been some successes with using biological control agents to control pests, not all have been effective. In some instances biological control has been detrimental to non-target organisms. Biological control is an area of active research yet many of the tools and techniques in this field are still in the experimental stages and have not been approved for use.

Biological control agents are classified as “Classic” or “General”. Classic biological control agents are those, which are host-specific and attack only those species targeted for control. These biological control agents typically do not completely eradicate their host. Instead, they eventually develop a typical “predator-prey” relationship where both populations fluctuate around a given population mean density. Therefore, classic control agents do not eliminate their target species but, if successful, maintain the target species at a lower population density. General biological control agents are not host-specific and will target many other organisms. These are of limited use when attempting to control specific species.

A third type of biological control agent is those that have not evolved with the target species but will degrade the target species if it is present. These control agents are less common but show some promise in controlling introduced species.

Grass Carp: Grass carp (or White Amur) are plant-consuming fish native to China and Siberia. They can be used as a (general) biological control agent to control aquatic plants. Although it is proposed that they have feeding preferences for certain plant species, if stocked at a high rate will feed on all plant species. The rate at which they are stocked depends primarily on the number of vegetated acres and secondarily on the desired level of control, climate, water temperature, and other site-specific conditions. The recommended maximum stocking rate in Washington is 25 fish per acre (Bonar et al. 2002). A study of grass carp usage in Washington has indicated that in most cases grass carp either eat all the vegetation in the lake or have a negligible impact on plant levels. Paradoxically, even in those lakes where they have had negligible impact on aquatic plants, surveys of lake residents indicate an overall high level of satisfaction with using the grass carp as a plant control method.

Only sterile (triploid) grass carp may be stocked in waters in the state of Washington. Imported from out-of-state, these fish must be certified as sterile and disease-free. In order to prevent escape, waters with inlets and outlets must be screened prior to stocking grass carp. Due to predation and natural mortality, grass carp must be restocked on a periodic basis.

Water quality may improve after stocking grass carp as dense areas of vegetation are reduced (WDFW 1990). However, if the majority of aquatic plants are removed, it is likely that algae may become very abundant due to the increased availability of light and nutrients. Moderate control of aquatic plants using grass carp is difficult to achieve, and they should be stocked only in waters were removal of all aquatic plants is and acceptable condition.

Advantages of Grass Carp:

- are a biological control option for plant control,
- are inexpensive and may provide long-term plant control.

Disadvantages of Grass Carp:
- may take several years to achieve tangible and measurable decrease in plant biomass
- may alter composition of plant community without decreasing overall biomass,
- screening may be necessary to prevent escape and allow for salmonid migration,
- may result in increased turbidity
- no good predictions of the amount of control that will be achieved

Costs of Grass Carp:
- \$10.00 to \$15.00 per fish (plus delivery),
- typically \$50 to \$200 per acre,
- screening costs (if necessary) are site-specific.

Application for Roses Lake Aquatic Plant Management:
Grass Carp may not be an appropriate control method in Roses Lake since in cases where they are over-stocked they can cause re-suspension of bottom sediments which would be a concern due to the DDT derivatives buried in the sediments. Also, the Grass Carp will not remove plants like water lilies or bulrush, as they would primarily be of use only to control submersed species.

Developing Technique/Milfoil Weevils**:** The milfoil weevil, *Euhrychiopsis lecontei*, has been associated with declines of Eurasian watermilfoil in the United States (e.g. Illinois, Minnesota, Vermont, and Wisconsin). Within the state of Washington, milfoil weevils are more abundant in eastern side of the Cascade Mountains, and feeds on both Eurasian and Northern watermilfoil (*M. sibiricum*). This milfoil control technique has shown some promise, although it not currently employed. Researches have a firm understanding at how these weevils influence plant growth at the individual plant level, but are still investigating weevil-milfoil dynamics on a larger scale (Creed 2000). More work is needed to determine which factors limit weevil densities and what lakes are suitable candidates for weevil usage in order to implement a cost effective control program.

Advantages of Milfoil Weevils:
- are a biological control option for milfoil control,
- likely to be relatively inexpensive and may provide long-term milfoil control,
- little to no disruption of native plant and animal communities.

Disadvantages of Milfoil Weevils:
- may not control milfoil to acceptable levels,
- may take several years to achieve tangible and measurable decrease in milfoil biomass,
- are susceptible to predation by small fishes,
- current success rate highly variable.

Costs of Milfoil Weevils:
- unknown at this time.

Application for Roses Lake Aquatic Plant Management:
The presence of sunfish in the lake would likely decrease the already limited effectiveness of the milfoil weevil. Given the extent of milfoil infestation and the eradication goal of this plan, use of the milfoil weevil is not recommended.

Chemical Controls
Aquatic herbicides are chemicals specifically formulated for use in water to kill or control aquatic plants. Herbicides approved for aquatic use by the United States Environmental Protection Agency (EPA) have been reviewed and are considered compatible with the aquatic environment when used according to label directions. However, some individual states, including Washington, also impose additional constraints on their use.

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and able to regrow. Non-selective, broad spectrum herbicides will generally affect all plants that they come in contact with. Selective herbicides will affect only some plants (often dicots - broad leafed plants like Eurasian watermilfoil (*Myriophyllum spicatum*) will be affected by selective herbicides whereas monocots like Brazilian elodea (*Egeria densa*) may not be affected). Most aquatic plants are monocots.

Because of environmental risks from improper application, aquatic herbicide application in Washington state waters is regulated and has the following restrictions:

- Applicators must be licensed by the Washington State Department of Agriculture.
- A discharge permit called a National Pollutant Elimination System Discharge (NPDES) permit must be obtained before aquatic herbicides can be applied to the waters of the state.
- Notification and posting are required and there may be additional mitigations proposed to protect rare plants or threatened and endangered species.

Ecology has developed a general NPDES permit for the management of noxious weeds growing in aquatic environments and a separate general permit for nuisance aquatic weeds (native plants) and algae control. For nuisance weeds (native species) and algae, applicators and the local sponsor of the project must obtain a NPDES permit from Ecology before applying herbicides to Washington waterbodies. For noxious weed control, applicators and their sponsors can obtain coverage under the Washington Department of Agriculture NPDES permit for noxious weed control.

Ecology currently issues permits for six aquatic herbicides and one algaecide for aquatic weed treatment for lakes, rivers, and streams. Weed control in irrigation canals is covered under another permit. Other herbicides are undergoing review and it is likely that other chemicals may be approved for aquatic use in Washington in the future.

The two contact herbicides registered and approved for use in Washington State are Endothall and Diquat. The four systemic herbicides registered and approved for use in Washington are Fluridone, triclopyr, Imazapyr, 2,4-D and Glyphosate.

Fluridone: Fluridone is an aquatic herbicide used to control common nuisance plants like pondweed and watermilfoil. It is not equally effective at killing all water plants and has been used in Washington to selectively remove certain nuisance weeds. It is absorbed by the leaves, shoots and roots of vascular plants and kills susceptible plants by inhibiting their ability to form carotene, a substance which plants need to maintain essential levels of chlorophyll. Damage in susceptible plants usually appears in 7-10 days after water treatment. Control of watermilfoil in Washington is often accomplished with rates as low as 10-20 parts per billion (ppb).

Use of fluridone does not pose a threat to human health or to fish and wildlife when used according to the label (SePRO 2002). While there is a 14-day precaution when using treated waters for irrigation (potentially longer with multiple treatments), there are no other water use restrictions when using the liquid formulation of fluridone.

Advantages of Fluridone:

- systemic herbicide, will kill entire target plants,
- variety of plants are susceptible depending on treatment rates and timing,
- can be used to target specific species with correct application rates,
- no known toxicity to humans, fish, and wildlife,
- no water use restrictions for fishing, swimming.

Disadvantages of Fluridone:

- plants need exposure to herbicide for lengthy period of time,
- usually requires multiple treatments in a growing season,
- costly
- high potential for herbicide drift, which dilutes chemical and may affect non-target plants.

Costs of Fluridone:

- -$900 to $1,100 per acre

Application for Roses Lake Aquatic Plant Management:
Whole lake and partial lake treatments with this herbicide were considered as potential control strategies during development of the plan. However, since the milfoil is still contained within two large patches, the use of fluridone was too costly when compared to herbicides that could more effectively and inexpensively be used for spot treatments.

2,4-D: There are two formulations of 2,4-D approved for aquatic use. The granular formulation contains the low-volatile butoxy-ethyl-ester formulation of 2,4-D (Trade names include: AquaKleen® and Navigate®). The liquid formulation contains the dimethylamine salt of 2,4-D (Trade name - DMA*4IVM). 2,4-D is a relatively fast-acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species. Both the granular and liquid formulations can be effective for spot treatment of Eurasian watermilfoil. 2,4-D has been shown to be selective to Eurasian watermilfoil when used at the labeled rate, leaving native aquatic species relatively unaffected.

The mode of action of this chemical is primarily as a stimulant of plant elongation and cell division (WDOE 2001). This post-emergent herbicide is primarily used to control watermilfoil and water stargrass. This herbicide targets dicots (e.g. milfoils) and leaves monocots unharmed. Because most aquatic plants are monocots, 2,4-D can often be used for selective plant control.

As with most herbicides, effectiveness of the treatment is dependent upon the timing of the application and density of the target plant community. Repeat applications may be required in areas of dense plant growth. Susceptible plants will begin to show signs of herbicide damage in one to two weeks after treatment, followed by plant mortality and decomposition.

Aqua-Kleen® and Navigate® (two name brands with 2,4-D as their active ingredient, should not be applied to waters used for irrigation, agricultural sprays, watering dairy animals or domestic water supplies. There are no set back restrictions (i.e. areas around water intake valves that should not be treated) mentioned in the labels. However, 2,4-D applications are generally permitted in waters if the people using water for the above purposes agree to suspend use until water in the treated area reaches the Federal Drinking water standard for 2,4-D; currently this standard is 0.07 mg/L. This concentration is generally obtained 3 to 5 days after treatment.

Advantages of 2,4-D:
- fast-acting systemic herbicide which is effective in removing selected plants,
- unlikely to damage non-target plants when applied at labeled rates,
- can be used on small to large scale sites,
- limited water use restrictions
- inexpensive when compared to other systemic herbicides.

Disadvantages of 2,4-D:
- application must be conducted 0.5 miles or greater from active drinking/domestic water withdrawals (unless approved by Ecology),
- 24 hour swimming advisory imposed by Ecology,
- treatment windows apply to areas where Endangered Species Act (ESA) listed salmonids and certain gamefish are present (according to WDFW specifications).

Costs of 2.4-D:
- $300 - $600 per acre.

Application for Roses Lake Aquatic Plant Management:
This was the primary control method selected during development of the IAVMP and is described in detail in the plan.

Triclopyr: This is a systemic herbicide with a water soluble triethylamine salt formulation containing three pounds of triclopyr acid equivalent per gallon. Triclopyr is effective on broad-leafed (dicots) plants such as Eurasian watermilfoil and does not harm monocots. Therefore, it is used for the selective removal of many noxious aquatic weeds including Eurasian watermilfoil and purple loosestrife. Triclopyr is a liquid product with a contact time requirement of 24 to 48 hours and can be used to treat specific areas. Susceptible plants exhibit epinasty (bending and twisting of plant tissue) within one day after treatment and die shortly thereafter.

Triclopyr does not accumulate in lake sediments or bottom-feeding fish, and has a low toxicity potential (SePRO 2003b). The primary means be which triclopyr breaks down is through photodegradation, with a typical half-life of 0.5 to 3 days.

Advantages of Triclopyr:
- selective for dicots such as milfoil,
- short contact time needed,
- kills entire target plant,
- potential for long-term control.

Disadvantages of Triclopyr:
- 12 hour swimming restriction,
- new product so there is little application history
- high cost

Costs of Triclopyr:
- $1,700 per acre (assumes maximum label rate applied).

Application for Roses Lake Aquatic Plant Management:
This herbicide did not compare favorably with the use of 2,4 D when the cost/area treated and long term efficacy were weighed.

Glyphosate: This systemic broad spectrum herbicide (trade names include Rodeo®, Aquamaster®, or AquaPro®) is used to control floating-leaved plants like waterlilies and shoreline plants like purple loosestrife. It is generally applied as a liquid to the leaves. Glyphosate does not work on underwater plants such as Eurasian watermilfoil. Although glyphosate is a broad spectrum, non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants can take several weeks to die and a repeat application is often necessary to remove plants that were missed during the first application.

Glyphosate should be applied by experienced and state-licensed (and insured) personnel. A NPDES Noxious Weed permit is required to apply glyphosate. There are no water-use restrictions associated with spraying glyphosate. However, the applicator is responsible for applying the herbicide in compliance with the product label and the NPDES Noxious Weed permit.

Advantages of Glyphosate:
- fast acting injury to plant tissue,
- low toxicity,
- not persistent in environment,
- spot treatments possible
- low cost.

Disadvantages of Glyphosate:
- repeat application often necessary
- non-target plant impacts sometimes difficult to mitigate as this is a fairly broad-spectrum.

Costs of Glyphosate:
- -\$250.00 - 350.00 per treated acre
- per acre costs higher when treated area < 5 acres

Application for Roses Lake Aquatic Plant Management:
This control method is appropriate for use on the fragrant waterlilies and reed canarygrass and was included as a recommendation in the IAVMP.

Endothall: Endothall is a fast-acting non-selective contact herbicide, which destroys the vegetative part of the plant but generally does not kill the roots. Endothall may be applied in a granular or liquid form. Typically endothall compounds are used primarily for short-term (one season) control of a variety of aquatic plants. However, there has been some recent research that indicates that when used in low concentrations, endothall can be used to selectively remove exotic weeds; leaving some native species unaffected. Because it is fast acting, endothall can be used to treat smaller areas effectively. Endothall is not effective in controlling Canadian waterweed (Elodea canadensis) or Brazilian elodea.

There are several water-use restrictions associated with the use of Endothall. At application rates needed to control Eurasian watermilfoil (2.0 to 4.0 ppm) the water-use restrictions are: do not consume fish taken from treated areas for three days and do not use water from treated areas for watering livestock, preparing agricultural sprays for food crops, for irrigation or for domestic purposes for 14 days after application. There is no swimming restriction for Endothall products. However, Ecology recommends waiting 24 hours after the herbicide treatment before swimming, although there is no official label restriction for swimming. Fish toxicity is not a factor, according to the product labels, at doses below 100 ppm (Cerexagri 2003).

Advantages of Endothall:
- fast acting injury to plant tissue,
- little or no off-target drift impacts,
- spot treatments possible.

Disadvantages of Endothall:
- only provides temporary reductions in plant biomass (does not kill plant roots),
- non-target plant impacts are difficult to mitigate as this is a fairly broad-spectrum ,
- higher water-use restrictions relative to other herbicides,

Costs of Endothall:
- -\$650.00 per treated acre

Application for Roses Lake Aquatic Plant Management:
This herbicide was approved for consideration for long term control of aquatic plants if native plants should reach nuisance levels after the milfoil is eradication. Its use was restricted to the

area at the southeast end of the lake where shoreline property has been developed and is used recreationally.

<u>Diquat</u>: Diquat is applied as a liquid and is a fast-acting non-selective contact herbicide, which destroys the vegetative part of the plant but does not kill the roots. Diquat is effective on a variety of submersed plants, including Eurasian watermilfoil, and also some types of filamentous algae. Diquat kills plants rapidly, potentially causing a depletion of oxygen and release of nutrients from plant decay into the water column. Typically diquat is used primarily for short-term (one season) control of a variety of submersed aquatic plants. Herbicide drift is usually minimal and it can be used to treat specific areas of the water. However, diquat may be less effective if applied to murky or turbid waters or areas with dense algal blooms. Also, repeat applications may be necessary for season-long plant control.

Diquat has slight toxicity to most animals and freshwater fish. It is slightly too highly toxic to aquatic invertebrates. However, Ecology approved Diquat for use in nuisance and noxious weed control (WDOE 2003) based on the completion of a Final Risk Assessment and the Final Supplemental Environmental Impact Statement for Diquat Bromide (WDOE 2002a and b).

Water use restrictions for the use of Diquat applications at a rate of two gallons Reward per surface acre (appropriate rate for Eurasian watermilfoil control) are three days for drinking water, one day for livestock drinking, three days for irrigation to turf and ornamental and five days for irrigation to food crops. There is no restriction for fishing or swimming in treated waters (Zeneca 1997).

Advantages of Diquat:
- rapid acting and effective against most plant species,
- does not bioaccumulate in aquatic organisms,
- no fishing or swimming restriction.

Disadvantages of Diquat:
- persistent, especially in sediments (although chemically inactive),
- some water-use restrictions in place,
- potentially toxic to aquatic organisms,
- repeat applications may be needed,
- rapid action may cause oxygen depletion and rapid release of nutrients into water
- only provides temporary (one to two season) control.

Costs of Diquat:
- $300 - $400 per acre for Reward®

Application for Roses Lake Aquatic Plant Management:
This herbicide was an option considered for seasonal control of Eurasian watermilfoil in Roses Lake.

REFERENCES – APPENDIX B

Applied Biochemist, Inc. 2000. Product label for Navigate® Aquatic Herbicide. Milwaukee, WI.

Bonar, S.A., B. Bolding, and M. Divens. 2002. Effects of Triploid Grass Carp on Aquatic Plants, Water Quality, and Public Satisfaction in Washington State. North American Journal of Fisheries Management 22:98-105.

Cerexagri, Inc. 2003. Product label for Aquathol K® Aquatic Herbicide. King of Prussia, PA.

Creed, R. P., and S. P. Sheldon. 1995. Weevils and watermilfoil: did a North American herbivore cause the decline of an exotic plant? Ecological Applications. 5:1113- 1121.

SePRO Corporation. 2002. Product labels for Sonar AS®, SRP®, PR®, and Q® Aquatic Herbicides. Carmel, IN.

SePRO Corporation. 2003a. Product label for Renovate® Aquatic Herbicide. Carmel, IN.

SePRO Corporation. 2003b. Product information for Renovate Aquatic Herbicide. Internet website: http://www.sepro.com/pdf_lit/aquatics/Renovate_FAB.pdf.

Washington Department of Ecology (WDOE). 1994. A Citizen's manual for Developing Integrated Aquatic Plant Management Plans. Publication 93-93. Water Quality Financial Assistance Program. Olympia, WA.

Washington Department of Ecology (WDOE). 2001. Final Supplemental Environmental Impact Statement Assessment of Aquatic Herbicides. Publication No's 00-10-040 through 00-10-045. Olympia, WA.

Washington Department of Ecology (WDOE). 2002a. Final Risk Assessment for Diquat Bromide. Publication No. 00-10-046. Olympia, WA.

Washington Department of Ecology (WDOE). 2002b. Final Supplemental Environmental Impact Statement Assessment for Diquat. Publication No. 00-10- 052. Olympia, WA.

Washington Department of Ecology (WDOE). 2003. Minor Permit Modification for Permit No. WAG-994000, Aquatic Nuisance Plant and Algae Control NPDES General Permit; and Permit No. WAG-993000, Aquatic Noxious Wee Control NPDES General Permit regarding Conditions for use of Diquat. Olympia, WA.

Washington Department of Fish and Wildlife (WDFW). 1990. Grass Carp use in Washington. Fisheries Management Division Publication 90-4. Olympia, WA.

Zeneca Professional Products. 1997. Product label for Reward® Landscape and Aquatic Herbicide. Wilmington, DE.

PERMITTING AND HERBICIDE INFORMATION

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Permitting and Herbicide Information

The purpose of this appendix is to provide general information on permitting requirements and associated with implementation of the Roses Lake IAVMP and also to provide fact sheets on the herbicides recommended for use; liquid 2,4-D, glyphosate, trichlopyr and diquat.

Permit Requirements

Most aquatic plant management tools can have an adverse impact on the environment if applied incorrectly or if too much vegetation is removed from a lake or river system. Because of this, there are a number of permits required to perform control work.

Project specific permitting for in-lake treatment of noxious weeds and all nuisance aquatic plant control activities is regulated through an Ecology State Waste General Permit. The permit and its provisions is currently being revised and scheduled for issuance in March of 2006. The general permit primarily applies to discharges to lakes and rivers. The applicator hired by an individual or lake group wishing to apply an aquatic herbicide must submit an application for coverage under this permit. Ecology will be developing application instructions, permit information, and an online application by March 2006.

An Hydraulic Permit Approval (HPA) permit is also required from Washington Department of Fish and Wildlife (WDFW) for any in water or shoreline work. However, WDFW has developed an informational pamphlet that serves as the permit. Citizens, units of government, or private weed control firms can obtain this pamphlet from WDFW. The pamphlet serves as the permit provided the conditions are read and followed. There is generally no need to submit any further paperwork. There are a number of general provisions that must be followed for all of the techniques described in this report. Not all of these provisions are required for each control method. The following common technical provisions are applicable to numerous control techniques and are listed here to avoid repetition.

Common Provisions from the HPA Pamphlet

- Removal of detached plants and plant fragments from the watercourse shall be as complete as possible. This is especially important when removing or controlling aquatic noxious weeds.
- Detached plants and plant fragments shall be disposed of at an upland site so as not to re-enter state waters.
- Work shall be conducted to minimize the release of sediment and sediment-laden water from the project site.
- Extreme care shall be taken to ensure that no petroleum products, hydraulic fluid or other deleterious material from equipment used are allowed to enter or leach into the watercourse.
- If at any time as a result of project activities or water quality problems, fish life are observed in distress or a fish kill occurs, operations shall cease and both the Department of Fish and Wildlife and the Department of Ecology shall be notified of the problem

immediately. The project shall not resume until further approval is given by the Department. Additional measures to mitigate impacts may be required.

- Every effort shall be made to avoid the spread of plant fragments through equipment contamination. Persons or firms using any equipment to remove or control aquatic plants shall thoroughly remove and properly dispose of all viable residual plants and viable plant parts from the equipment prior to the equipment's use in a body of water.
- Existing fish habitat components such as logs, stumps, and large boulders may be relocated within the watercourse if necessary to properly install the bottom barrier, screen, weed roller or to operate the equipment. These habitat components shall not be removed from the watercourse.
- Alteration or disturbance of the bank and bank vegetation shall be limited to that necessary to conduct the project. All disturbed areas shall be protected from erosion, within seven calendar days of completion of the project, using vegetation or other means. The banks shall be revegetated within one year with native or other approved woody species. Vegetative cuttings shall be planted at a maximum interval of three feet (on center), and maintained as necessary for three years to ensure 80% survival. Where proposed, planting densities and maintenance requirements for rooted stock will be determined on a site-specific basis. After prior authorization by the Department, the requirement to plant woody vegetation may be waived for areas where the potential for natural revegetation is adequate, or where other engineering or safety factors preclude them.
- Due to potential impacts to sockeye spawning areas, prior authorization by the Department shall be required for activities in Baker Lake and Lakes Osoyoos, Ozette, Pleasant, Quinault, Sammamish, Washington, and Wenatchee. Authorization may or may not be given for the activity, and if given, may require mitigation through a written agreement between the applicant and the Department for impacts by the activity to the spawning area.

HERBICIDE FACT SHEETS

One page fact sheets for each of the two herbicides recommended for immediate use (2,4-D and glyphosate) as well as the two herbicides that are listed for possible follow-up control (trichlopyr and diquat) are provided on the following pages. More detailed information on health and toxicity testing associated with these herbicides is available at:
http://www.doh.wa.gov/ehp/ts/fs.htm.

2, 4 – D
(DIMETHYLAMINE SALT)

- Tradenames include DMA*4IVM ® and Weedar64®.
  - An herbicide used to control Eurasian Watermilfoil and other broadleaved species
  - Fast acting, systemic herbicide
  - Effective for spot treatment of Eurasian Watermilfoil
  - When used at the labeled rate, selective for Eurasian milfoil, leaving native aquatic species relatively unaffected
  - Applied directly to the lake at a rate of 2.5 to 10 gallons of concentrate (3.8 lbs active ingredient/gal) per acre.
  - Acute toxicity for some aquatic organisms include:
    1. Bluegill – 524 mg/L
    2. Trout – 250 mg/L
    3. Water fleas – 184 mg/L
- Direct ingestion of >50 mg per kg of body weight is highly toxic to humans and animals and may be a potential carcinogen.
- Water should not be used for drinking within one month of application.
- Absorbed through roots, affecting growth of new shoots.
- Plants are killed within a few days.
  - For further information see:
    1. http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html
    2. http://www.ecy.wa.gov/pubs/0010043.pdf
    3. http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC33440

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GLYPHOSATE

- Tradenames include Rodeo®, AquaMaster®, and AquaPro®. An herbicide used to control emergent (e.g. cattail) and floating-leaved (e.g. white water lily) plants.
- When applied at the right time of year and under the right conditions, it has potential to act as a permanent contact herbicide
- It is not selective for one or a few plants; that is, it affects most emergent vegetation.
- Applied as a liquid by spraying onto plants along with a surfactant and a dye
- There is a drinking water use restriction for this herbicide
- This herbicide typically applied at a rate of about 0.2 mg glyphosate per liter of water (0.2 mg/L)
- Acute toxicity for some aquatic organisms include:
    1. Bluegill - >1000 mg/L
    2. Rainbow trout - >1000 mg/L
    3. Water fleas – 930 mg/L
- Practically non-toxic to mammals
- Nicotine, aspirin, and caffeine are more lethal than glyphosate when ingested in large quantities
- Breaks down rapidly, non-detectable within 24 hours
- Plants die within a few weeks
- A repeat application is sometimes necessary
- For further information see:
    1. http://www.cygnetwest.com/rodeomsds.pdf
    2. http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html
    3. http://www.ecy.wa.gov/pubs/0010040.pdf

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TRICLOPYR

- Tradename - Renovate®.
- A fast acting, systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species such as purple loosestrife
- Applied in liquid form
- Maximum label rate is 2.5 mg/L
- Water use restrictions:
    1. Swimming – 12 hours.
    2. Irrigation – 14 days
- Acute Toxicity for some aquatic organisms include:
    1. Rainbow Trout - 117 mg/L
    2. Bluegill Sunfish – 148 mg/L
    3. Daphnia – 1140 mg/L
- Practically non-toxic to fish, birds and bees
- Reported half-lives in water are 2.8 to 14.1 hours
- For further information:
    1. http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html
    2. http://www.ecy.wa.gov/pubs/0410018.pdf
    3. http://aquat1.ifas.ufl.edu/guide/triclolab.pdf

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DIQUAT

- Tradename - Reward®
- An herbicide used to control submerged (e.g. pondweeds) plants.
- Shown to be effective control for of Brazilian Elodea
- It does not permanently kill plants but provides seasonal control for one or more years.
- It is not selective for one or a few plants; that is, it affects most submerged vegetation.
- Applied as a liquid by direct injection into the water
- Water use restrictions include:
    1. fish consumption and swimming – no restriction (24-hour swimming advisory)
    2. livestock consumption – 1 day
    3. drinking water – 3 days
    4. irrigation for turf and ornamentals – 3 days
    5. irrigation for food crops – 5 days
- The maximum application rate allowable is 0.37 ppm
- Acute toxicity for some aquatic organisms include:
    1. Bluegill – 13.9 ppm
    2. Trout – 14.8 ppm
    3. Water fleas – 0.77 – 1.19 ppm
- Only slightly toxic to mammals in large amounts
- Rapidly binds to organic particles and sediment
- Plants are killed within a few days and fall out of the water column within a week or two
- Control lasts all season or longer.
- For further information see:
    1. http://www.syngentaprofessionalproducts.com/labels/Index.asp?nav=PrdLst&F=PrdDsp
    2. http://www.ecy.wa.gov/biblio/0210052.html
    3. http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html

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APPENDIX D

U.S. FWS WETLAND MAP OF ROSES LAKE

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U.S. Fish & Wildlife Service
Wetlands Online Mapper

Roses Lake - Chelan County

Map Center: 120° 9' 24.60" W, 47° 54' 25.5" N

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Roses Lake with Wapato appearing above and Dry Lake to the left.

Map Scale Unavailable (unprojected data)

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